Neonatal Guidelines 2025–28

The Bedside Clinical Guidelines Partnership
in association with the
West Midlands Perinatal Network

NHS

Published by the Bedside Clinical Guidelines Partnership and West Midlands Perinatal Network

© 2025–28 Bedside Clinical Guidelines Partnership (University Hospital of North Midlands NHS Trust acting as authorised copyright owner)

All rights reserved

NOT TO BE REPRODUCED OR DISTRIBUTED WITHOUT PERMISSION

West Midlands Perinatal Network comprises:

Birmingham Women's and Children's NHS Foundation Trust
George Eliot Hospital NHS Trust
South Warwickshire University NHS Foundation Trust
The Dudley Group NHS Foundation Trust
KIDS NTS
The Midland Metropolitan University Hospitals NHS Trust
The Royal Wolverhampton NHS Trust
The Shrewsbury and Telford Hospital NHS Trust
University Hospitals Birmingham NHS Trust
University Hospitals of North Midlands NHS Trust
University Hospitals Coventry and Warwickshire NHS Trust
Walsall Healthcare NHS Trust
Worcestershire Acute Hospitals NHS Trust
Wye Valley NHS Trust

The Bedside Clinical Guidelines Partnership comprises**:**

County Durham and Darlington NHS Foundation Trust
The Dudley Group NHS Foundation Trust
Manchester University NHS Foundation Trust
Mid and South Essex University Hospitals Group
North Cumbria Integrated Care NHS Foundation Trust
Northern Care Alliance NHS Group
Shrewsbury and Telford Hospital NHS Trust
Surrey and Sussex Healthcare NHS Trust
The Royal Wolverhampton Hospitals NHS Trust
University Hospitals Birmingham NHS Foundation Trust
University Hospitals of Morecambe Bay NHS Trust
University Hospitals North Midlands NHS Trust
Walsall Healthcare NHS Trust

CONTENTS • 1/3

Acknowledgements	6
Commonly used abbreviations	7
Preface	10
ADMISSION AND DISCHARGE	
Admission to neonatal unit	16
Death and seriously ill babies	88
Discharge from neonatal unit	99
Follow-up of babies discharged from neonatal unit	133
Labour ward calls	259
Transport and retrieval	418
CARDIOVASCULAR	
Cardiac murmurs	54
Congenital heart disease duct-dependent lesions [Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions]	68
ECG abnormalities	110
Heart failure	151
Hypertension	179
Hypotension: haemodynamic compromise	198
Patent ductus arteriosus	323
Pericardiocentesis	327
Supraventricular tachycardia	391
Vascular spasm and thrombosis	439
CRITICAL CARE	
Babies born extremely prematurely: 22^{+0}–26^{+6} weeks gestation	33
Contacting a consultant	80
Delayed cord clamping	90
Dropped baby	107
Golden hour – preterm babies <28 weeks' gestation	142
Hydrops fetalis	167
Massive haemorrhage	268
Pain assessment and management	312
Resuscitation	361
Subgaleal haemorrhage (SGH)	385
Sudden unexpected postnatal collapse in first week of life	388
Temperature management and prevention of hypothermia	400
DEVELOPMENTAL CARE	
Developmental care	92
Environment and noise	117
Kangaroo care	252
Non-nutritive sucking (NNS)	294
Positioning	330
ENDOCRINE/METABOLISM	
Hyperglycaemia	169
Hyperkalaemia	172
Hypernatraemic dehydration	176
Hypocalcaemia	183
Hypoglycaemia	186
Hypokalaemia	195
Hypothyroidism	207
Inherited metabolic disorders (IMD)	229
Intravenous fluid therapy	237
Medium-Chain Acyl-CoA Dehydrogenase Deficiency (MCADD) – early management of babies with family history	271
Metabolic bone disease	272
Thyroid disease (management of babies born to mothers with thyroid disease)	408
GASTROENTEROLOGY	
Ankyloglossia (tongue-tie) – division for breastfeeding	20
Gastro-oesophageal reflux disease (GORD)	135
Jaundice	249

CONTENTS ● 2/3

Liver dysfunction in preterm babies	260
Nasogastric tube administration of feed, fluid or medication	283
Necrotising enterocolitis (NEC)	289
HAEMATOLOGY	
Blood group incompatibilities (including Rhesus disease)	38
Coagulopathy	62
Polycythaemia	328
Thrombocytopenia	404
Transfusion of red blood cells	414
Vitamin K	461
INFECTION	
BCG immunisation	35
Conjunctivitis	75
Cytomegalovirus (CMV)	85
Group B streptococcal colonisation of mother	145
Hepatitis B and C	154
Herpes simplex virus (HSV)	157
Human immunodeficiency virus (HIV)	164
Immunisations	214
Infection (congenital)	72
Infection (late onset)	217
Infection in first 72 hours of life	222
Infection prevention	225
Kaiser Permenante sepsis risk calculator	254
Multi drug resistant organism colonisation (MRSA, ESBL etc.)	278
Palivizumab	317
Syphilis – babies born to mothers with positive serology	397
Tuberculosis (investigation and management following exposure in pregnancy)	422
Varicella	436
NEUROLOGY	
Abstinence syndrome	13
Down syndrome – initial management	103
Hypotonia (floppy baby)	209
Hypoxic ischaemic encephalopathy (HIE) including preparation for active cooling	158
Microcephaly **NEW**	274
Post haemorrhagic ventricular dilatation	333
Seizures	370
Stroke	383
Upper limb birth injuries including brachial plexus injury	432
NUTRITION	
Bottle feeding in the neonatal unit	42
Breast milk expression	44
Breast milk handling and storage	46
Breastfeeding	48
Nutrition and enteral feeding	295
Parenteral nutrition	319
Progression to suck feeding in preterm babies	336
Reluctant feeding term baby **NEW**	355
PRACTICAL PROCEDURES	
Arterial line insertion	29
Arterial line sampling	31
Cannulation – peripheral venous	53
Chest drain insertion – Seldinger technique	55
Chest drain insertion – Traditional	58
Consent	77
Endotracheal tube (ETT) suctioning	114
Exchange transfusion	122
Extravasation injuries	130
Growth monitoring	146
Intraosseous infusion	235

CONTENTS ● 3/3

Intubation	242
Intubation – difficult	245
Long line insertion (peripherally sited)	263
Monitoring and observations on neonatal unit **NEW**	276
Nasogastric tube insertion	285
Prostaglandin infusion	340
Skin biopsy for inborn errors of metabolism	375
Skin care	377
Transillumination of the chest	417
Umbilical artery catheterisation and removal	424
Umbilical venous catheterisation and removal	428
Venepuncture	441
RENAL	
Renal failure	356
Urinary tract abnormalities diagnosed antenatally	433
RESPIRATORY	
Apnoea and bradycardia	27
Airway clearance (intubated babies) **NEW** [previously Chest physiotherapy (percussion)]	18
Chronic lung disease	60
Nitric oxide	292
Oxygen on discharge	309
Oxygen saturation targets	311
Pulmonary hypertension	344
Pulmonary haemorrhage	342
Surfactant replacement therapy	394
Transcutaneous CO_2 and O_2	411
Ventilation: continuous positive airway pressure (CPAP)	443
Ventilation: conventional	447
Ventilation: high-flow nasal cannulae (HFNC)	451
Ventilation: high frequency oscillatory ventilation (HFOV)	452
Ventilation: synchronous positive pressure ventilation (SIPPV)	455
Ventilation: volume-targeted (volume guarantee/targeted tidal volume)	458
Ventilator associated pneumonia	460
SCREENING	
Antenatal ultrasound abnormalities	25
Bloodspot screening	40
Cranial ultrasound scans	82
Developmental dysplasia of the hip (DDH)	94
Developmental follow-up of children born preterm	97
Disorders of sexual development	101
Examination of the newborn	118
Hearing screening	149
Pulse oximetry (universal) screening	348
Retinopathy of prematurity (ROP)	367
Sacral dimple	369
SURGICAL GUIDELINES	
Anorectal malformation in NNU before transfer to surgical centre	22
Broviac line insertion	50
Congenital diaphragmatic hernia (CDH)	64
Exomphalos – initial management	127
Gastroschisis	137
Inguinal hernia	228
Intra-abdominal cysts	233
Myelomeningocele (MMC)	281
Oesophageal atresia	304
Oesophageal perforation	307
Rectal washout using syringe method	351
Recycling stoma losses via a mucus fistula	353
Stoma management (gastrointestinal)	379

ACKNOWLEDGEMENTS • 1/1

We would like to thank the following for their assistance in producing this edition of the Neonatal Guidelines on behalf of the Bedside Clinical Guidelines Partnership and West Midlands Neonatal Operational Delivery Network

Contributors

Nisha Aggarwal
Diana Aguirre
Oluwaseyi Alake
Suren Arul
Meena Bankhakavi
Shona Brothwell
M Cawsey
Ceri Chadwick
Harish Chandran
Fiona Chambers
Sara Clarke
Joanne Cookson
Cheryl Curson
Anna Darbyshire
Sanjeev Deshpande
Eileen Foster
Emma Foulerton
Victoria Fradd
Vidya Garikapati
Brendan George
Anurag Girdhar
Sonia Goyal
Harsha Gowda
Lindsay Halpern
M Harris
Tracey Hill
Louise Hirons
Gemma Holder
Helen Jarvis
Rashida Javid
Andrea Jester
Sheilah Kamupirah
Pallavi Karkhanis
Ashok Karupaiah
Arthi Lakshmanan
Anthony Lander
Katherine Matthews
Paddy McMaster
Rashmi Mehta
Alison Moore
Lindsay Mulligan
K Muneer
M Muorah
Mona Noureldein
Kate Palmer
Katy Parnell
Meghana Pearson
Anjali Pektar
Alex Philpott
Julian Raiman
Nikitha Rajaraman
Tristan Ramcharan
Narasimha Rao
Sagarika Ray
Sophie Reynolds
Victoria Riches
Desiderio Rodrigues
Tunde Salawu
Cathryn Seagrave
Pooja Siddhi
Asha Shenvi
Anju Singh
Jaideep Singh
S. Sivakumar
Emily Slack
Anna Smith
Nicola Staton
Imogen Storey
Pinki Surana
Melanie Sutcliffe
Julie Taylor
Arumugavelu Thirumurugan
Louise Thompson
Gergely Toldi
Christina Trigg
Julia Uffindell
Alison Ventriss
Suresh Vijay
Amy Walker
Julie-Ann Watford
Charlotte Xanthidis
Rachel Yew

Neonatal Editors

Pooja Siddhi
Sagarika Ray

Bedside Clinical Guidelines Partnership

Kathryn McCarron
Naveed Mustfa
Kate Palmer
Mathew Stone

West Midlands Perinatal Network

Lynsey Clarke
Emma Foulerton
Harsha Gowda

The editors would like to thank the following people/organisations for allowing us to use/adapt their guidelines:

Birmingham Children's Hospital – Skin biopsy guideline

Dr Carl Kuschel
Auckland District Health Board
Auckland, New Zealand – Ventilation guideline

Birmingham Women's Hospital Neonatal Unit – Extravasation injuries guideline

Guy's and St Thomas' NHS Trust – Transcutaneous monitoring guideline

COMMONLY USED ABBREVIATIONS ● 1/3

ACTH	Adrenocorticotrophic hormone
ADH	Antidiuretic hormone
aEEG	Cerebral function monitoring
ALT	Alanine aminotransferase
APTT	Activated partial thromboplastin time
ASD	Atrial septal defect
AST	Aspartate aminotransferase
AVSD	Atrioventricular septal defect
BAPM	British Association of Perinatal Medicine
BCG	Bacille Calmette-Guerin
BiPAP	Biphasic CPAP
BPD	Bronchopulmonary dysplasia
CAH	Congenital adrenal hyperplasia
CAMT	Congenital amegakaryocytic thrombocytopenia
CCAM	Congenital cystic adenomatoid malformation
ccTGA	Congenitally corrected transposition of the great arteries
CDH	Congenital dislocation of hips or congenital diaphragmatic hernia
CFAM	Cerebral function analysis monitor
CGA	Corrected gestational age
CH	Congenital hypothyroidism
CHD	Congenital heart disease
CLD	Chronic lung disease
CMPI	Cow’s milk protein intolerance
CMV	Cytomegalovirus
CNS	Central nervous system
CoNS	Coagulase-negative staphylococcus
CPAP	Continuous positive airway pressure
CRP	C-reactive protein
CVL	Central venous line
CVS	Cardiovascular
DCT	Direct Coombs test
DDH	Developmental dysplasia of the hip
DEBM	Donor expressed breast milk
DHEA	Dihydroepiandrostenedione
dHT	Dihydrotestosterone
DIC	Disseminated intravascular coagulation
DSD	Disorders of sexual development
EBM	Expressed breast milk
ECF	Extracellular fluid
ECG	Electrocardiogram
ECMO	Extracorporeal membrane oxygen
EDD	Expected date of delivery
EFM	Electronic fetal monitoring
ELBW	Extremely-low-birth-weight
EMG	Electromyography
ETT	Endotracheal tube
EUT	Extrauterine transfer
FFP	Fresh frozen plasma
FSID	Foundation for the Study of Infant Deaths
GBS	Group B streptococcus

COMMONLY USED ABBREVIATIONS ● 2/3

GGT	Gamma-glutamyl transaminase
GLUT 1	Glucose transporter defect
GOR	Gastro-oesophageal reflux
hCG	Human chorionic gonadotropin
Hct	Haematocrit
HCV	Hepatitis C virus
HFNC	High-flow nasal cannulae
HFOV	High frequency oscillatory ventilation
HIE	Hypoxic ischaemic encephalopathy
HIV	Human immunodeficiency virus
HLHS	Hypoplastic left heart syndrome
HPA	Human platelet antigens
HTLV	Human T-cell lymphotropic virus
ICCP	Integrated comfort care pathway
IMD	Inherited metabolic disorders
iNO	Inhaled nitric oxide
IPPV	Intermittent positive pressure ventilation
ITP	Immune thrombocytopenic purpura
IUGR	Intrauterine growth retardation
IUT	In-utero blood transfusion or in-utero transfer
IVC	Inferior vena cava
IVH	Intraventricular haemorrhage
IVIG	Intravenous immunoglobin
LHRH	Luteinizing hormone releasing hormone
LMA	Laryngeal mask airway
LP	Lumbar puncture
LRTI	Lower respiratory tract infection
LSE	Left sternal edge
LV	Left ventricle
LVOT	Left ventricular outflow tract
MAP	Mean airway pressure or mean arterial pressure
MAS	Meconium aspiration syndrome
MCADD	Medium chain acyl co-A dehydrogenase deficiency
MDT	Multidisciplinary team
MEBM	Mother’s expressed breast milk
MSUD	Maple syrup urine disease
NAIT	Neonatal allo-immune thrombocytopenia
NEC	Necrotising enterocolitis
NGT	Nasogastric tube
NHSP	Newborn Hearing Screening Programme
NICU	Neonatal intensive care unit
NKHG	Non-ketotic hyperglycinaemia
NLS	Newborn life support
NNU	Neonatal unit
NPSA	National Patient Safety Agency
NTS	Neonatal Transport Service
OI	Oxygenation index
OPS	Oropharyngeal secretions
PACS	Picture archiving and communications system
PAT	Pain assessment tool

COMMONLY USED ABBREVIATIONS ● 3/3

PCOS	Polycystic ovary syndrome
PCR	Polymerase chain reaction
PDA	Patent ductus arteriosus
PEEP	Positive end expiratory pressure
PEP	Post-exposure prophylaxis
PFO	Patent foramen ovale
PIE	Pulmonary interstitial emphysema
PIH	Pregnancy-induced hypertension
PICC	Peripherally inserted central catheter
PIP	Peak inspiratory pressure
PIPP	Premature infant pain profile
PKU	Phenylketonuria
PN	Parenteral nutrition
PPHN	Persistent pulmonary hypertension of the newborn
PROM	Pre-labour rupture of membranes
PT	Prothrombin time
PTV	Patient triggered ventilation
PVL	Periventricular leukomalacia
PVR	Pulmonary venous return
RDS	Respiratory distress syndrome
ROP	Retinopathy of prematurity
RR	Respiratory rate
RVH	Right ventricular hypertrophy
SANDS	Stillbirth and Neonatal Death Society
SaO_2/SpO_2	Arterial/peripheral oxygen saturation
SGA	Small for gestational age
SIDS	Sudden infant death syndrome
SIMV	Simultaneous intermittent mandatory ventilation
SLE	Systemic lupus erythematosus
SPA	Supra-pubic aspiration
SSRI	Selective serotonin reuptake inhibitor
SVC	Superior vena cava
SVT	Supraventricular tachycardia
TAR	Thrombocytopenia absent radii
T_{exp}	Expiratory time
TEW	Transepidermal water
TGA	Transposition of the great arteries
THAM	Trometamol
T_{insp}	Inspiratory time
TTV	Targeted tidal volume
UAC	Umbilical artery catheter
UVC	Umbilical vein catheter
VLBW	Very-low-birth-weight
VLCFA	Very long chain fatty acids
VSD	Ventricular septal defect
V_t	Tidal volume
Vte	Expired tidal volume
VZIG	Varicella zoster immunoglobulin
VZV	Varicella-zoster virus
WCC	White cell count

PREFACE ● 1/3

These guidelines have been compiled as an aide-memoire for all staff concerned with the management of neonates, to work towards a more uniform standard of care across the West Midlands Perinatal Networks' hospitals (https://www.teamwmcn.nhs.uk/neonatal-guidelines)

These guidelines have been drafted with reference to published medical literature and amended after extensive consultation. Wherever possible, the recommendations made are evidence based. Where no clear evidence has been identified from published literature the advice given represents a consensus of the expert authors and their peers and is based on their practical experience.

No guideline will apply to every patient, even where the diagnosis is clear-cut; there will always be exceptions. These guidelines are not intended as a substitute for logical thought and must be tempered by clinical judgement in the individual patient and advice from senior colleagues.

There is a possibility that a guideline may be updated between publication and the next edition in 3 years' time. Any instrumental change in guideline before the next edition will be published on the network website https://www.teamwmcn.nhs.uk/neonatal-guidelines

The guidelines are advisory, NOT mandatory

Prescribing regimens and nomograms
The administration of certain drugs, especially those given intravenously, requires great care if hazardous errors are to be avoided. These guidelines do not include comprehensive guidance on the indications, contraindications, dosage and administration for all drugs. Please refer to the Neonatal Unit's preferred formulary; either the **Neonatal Formulary: Drug Use in Pregnancy and the First Year of Life, 8th Edition 2020**, or the **BNF for Children** available at https://bnf.nice.org.uk/. Adjust doses as necessary for renal or hepatic impairment.

Practical procedures
DO NOT attempt to carry out any of these procedures unless you have been trained to do so and have demonstrated your competence.

Legal advice
How to keep out of court:
- Write the patient's name and unit number on the top of each side of paper
- Time and date each entry
- Sign and write your name legibly after every entry
- Document acknowledgement of results of all investigations (including radiology)
- Document all interactions including discussions with parents (and who was present)

Supporting information
Where possible the guidelines are based on evidence from published literature. It is intended that evidence relating to statements made in the guidelines and its quality will be made explicit.

Where supporting evidence has been identified it is graded I to V according to standard criteria of validity and methodological quality as detailed in the table below. A summary of the evidence supporting each statement is available, with the original sources referenced (intranet/internet only). The evidence summaries are developed on a rolling programme which will be updated as the guideline is reviewed.

Level	Treatment benefits	Treatment harms	Prognosis	Diagnosis
1	Systematic review of randomized trials or n-of-1 trials	Systematic review of randomized trials, systematic review of nested case-control studies, n-of-1 trial with the patient you are raising the question about, or observational study with dramatic effect	Systematic review of inception cohort studies	Systematic review of cross sectional studies with consistently applied reference standard and blinding
2	Randomized trial or observational study with dramatic effect	Individual randomized trial or (exceptionally) observational study with dramatic effect	Inception cohort studies	Individual cross sectional studies with consistently applied reference standard and blinding
3	Non-randomized controlled cohort/follow-up study	Non-randomized controlled cohort/follow-up study provided there are sufficient numbers to rule out a common harm	Cohort study or control arm of randomized trial	Non-consecutive studies, or studies without consistently applied reference standards
4	Case-series, case-control studies, or historically controlled studies	Case-series, case-control, or historically controlled studies	Case-series or case-control studies, or poor quality prognostic cohort study	Case-control studies, or poor or non-independent reference standard
5	Mechanism-based reasoning	Mechanism-based reasoning	n/a	Mechanism-based reasoning

Excerpt from: OCEBM Levels of Evidence Working Group. The Oxford Levels of Evidence 2. Oxford Centre for Evidence-Based Medicine. 2011. http://www.cebm.net/index.aspx?o=5653

Evaluation of the evidence-base of these guidelines involves review of existing literature then periodical review of anything else that has been published since the last review. The editors encourage you to challenge the evidence provided in this document. If you know of evidence that contradicts, or additional evidence in support of the advice given in these guidelines, please forward it to the Clinical Guidelines Developer/Co-ordinator, bedsideclinicalguidelines@uhnm.nhs.uk).

Evidence-based developments for which funding is being sought

As new treatments prove more effective than existing ones, the onus falls upon those practising evidence-based healthcare to adopt best practice. New treatments are usually, but not always, more expensive. Within the finite resources of each Trust and of the NHS as a whole, adoption of these treatments has to be justified in terms of the improvements they will bring to the quality or cost-effectiveness of care. The priorities for funding new areas of treatment and patient care will be determined at Trust level.

Feedback and new guidelines

The Bedside Clinical Guidelines Partnership, and the West Midlands Neonatal Perinatal Networks have provided the logistical, financial and editorial expertise to produce the guidelines. These guidelines have been developed by clinicians for practice based on best available evidence and opinion. Any deviation in practice should be recorded in the patient's notes with reasons for deviation. The editors acknowledge the time and trouble taken by numerous colleagues in the drafting and amending of the text. The accuracy of the detailed advice given has been subject to exhaustive checks. However, any errors or omissions that become apparent should be drawn to the notice of the editors, via the Clinical Guidelines Developer/Co-ordinator, bedsideclinicalguidelines@uhnm.nhs.uk, so that these can be amended in the next review, or, if necessary, be brought to the urgent attention of users. Constructive comments or suggestions would also be welcome.

There are still many areas of neonatal care which are not included: please submit new guidelines as soon as possible for editorial comment.

For brevity, where the word 'parent(s)' is read, this means mothers, fathers, guardians or others with parental care responsibilities for babies.

exhaustive checks. However, any errors or omissions that become apparent should be drawn to the notice of the editors, via the Clinical Guidelines Developer/Co-ordinator, bedsideclinicalguidelines@uhnm.nhs.uk, so that these can be amended in the next review, or, if necessary, be brought to the urgent attention of users. Constructive comments or suggestions would also be welcome.

There are still many areas of neonatal care which are not included: please submit new guidelines as soon as possible for editorial comment.

For brevity, where the word ‘parent(s)’ is read, this means mothers, fathers, guardians or others with parental care responsibilities for babies.

ABSTINENCE SYNDROME ● 1/3

RECOGNITION AND ASSESSMENT

Definition

Neonatal withdrawal/abstinence syndrome (NAS)/neonatal opioid withdrawal syndrome (NOWS)

- Symptoms evident in babies born to opiate-dependent mothers and mothers on other drugs associated with withdrawal symptoms (generally milder with other drugs)

Timescale of withdrawal

- Signs of withdrawal from opiates (misused drugs, e.g. heroin) can occur <24 hr after birth
- Signs of withdrawal from opioids (prescribed drugs, e.g. methadone) can occur 3–4 days after birth, occasionally up to 2 weeks after birth
- Multiple drug use and nicotine/alcohol exposure can delay, confuse and intensify withdrawal signs in the first weeks of life

Minor signs

- Tremors when disturbed
- Tachypnoea (>60/min)
- Pyrexia
- Sweating
- Yawning
- Sneezing
- Nasal stuffiness
- Poor feeding
- Regurgitation
- Loose stools
- Sleeping <3 hr after feed (usual among breastfed babies)

Major signs

- Convulsions
- Profuse vomiting or diarrhoea
- Inability to co-ordinate sucking, necessitating introduction of tube feeding
- Baby inconsolable after 2 consecutive feeds

AIMS

- To identify withdrawal signs following birth
- To give effective medical treatment where necessary
- To promote bonding and facilitate good parenting skills
- To support and keep baby comfortable during withdrawal period
- To optimise feeding and growth
- To identify social issues and refer to appropriate agencies

ANTENATAL ISSUES

- Check maternal hepatitis B, hepatitis C and HIV status and decide on management plan for baby

Check maternal healthcare record for case conference recommendations and discuss care plan for discharge with safeguarding lead midwife/drug liaison midwife

Management of labour

- Make sure you know:
  - type and amount of drug(s) exposure
  - route of administration
  - when last dose was taken
- Neonatal team are not required to be present at delivery unless clinical situation dictates

IMMEDIATE TREATMENT

Delivery

- **Do not give naloxone** (can exacerbate withdrawal symptoms)
- Care of baby is as for any other baby, including encouragement of skin-to-skin contact and initiation of early breastfeeding, if this is mother's choice (see **Breastfeeding** guideline)

ABSTINENCE SYNDROME ● 2/3

After delivery

- Transfer to postnatal ward/transitional care and commence normal care
- Use local scoring systems for monitoring of signs of withdrawal (e.g. modified Lipsitz, modified Finnegan)
- Admit to NNU only if there are clinical indications
- Keep babies who are not withdrawing, feeding well and have no child protection issues with their mothers in postnatal ward/transitional care
- Babies who are symptomatic enough to require pharmacological treatment usually require admission to NNU
- Start case notes
- Take a detailed history, including:
  - social history, to facilitate discharge planning
  - maternal hepatitis B, hepatitis C and HIV status
  - enquire about any known other Hepatitis B residents at home as potential contacts
- Ensure postnatal baby check and daily review by paediatrician

As symptoms of withdrawal can be delayed, keep baby in hospital for ≥4 days

SUBSEQUENT MANAGEMENT

- Aims of managing a baby at risk of neonatal drug withdrawal are to:
  - maintain normal temperature
  - reduce hyperactivity
  - reduce excessive crying
  - reduce motor instability
  - ensure adequate weight gain and sleep pattern
  - identify significant withdrawal requiring pharmacological treatment
- Ensure baby reviewed daily by neonatal staff

Non-pharmacological treatment

- For all babies use non-pharmacological management as cornerstone of treatment:
  - keep baby with mother whenever possible
  - skin-to-skin/cuddles
  - low stimulus environment (quiet and low light)
  - containment/swaddling

Feeding

- Support mother in her choice of feeding method and encourage responsive feeding by mother
- Unless other contraindications co-exist or baby going for adoption, strongly recommend breastfeeding (see **Breastfeeding** guideline)
- Give mother all information she needs to make an informed choice about breastfeeding
- Drugs of misuse do not, in general, pass into breast milk in sufficient quantities to have a major effect in newborn baby
- Breastfeeding will certainly support mother in feeling she is positively comforting her baby, should he/she be harder to settle
- Breastfeeding reduces the need for and duration of pharmacological treatment
- No evidence of benefit from lactose free or hydrolysed formulas for bottle fed babies

Pharmacological treatment

- Reserved for babies with severe NAS
- Aimis to reduce distress and control potentially dangerous signs
- Minor signs (e.g. jitters, sweating, yawning) do **not** require treatment
- Scoring tool reduces subjectivity of assessment and provides threshold for consideration of pharmacological treatment
- Start treatment (after other causes excluded) if there is:
  - recurrent vomiting
  - profuse watery diarrhoea
  - poor feeding requiring tube feeds
  - inconsolability after 2 consecutive feeds
  - seizures

- When mother has been using an opiate or opioid, a morphine derivative is the most effective way to relieve symptoms
- When there has been multiple drug usage, phenobarbital may be more effective

Opioids
- If authorised by experienced doctor/ANNP start morphine 40 microgram/kg oral 4-hrly. In rare cases, and after discussion with consultant, it may be necessary to increase dose by 10 microgram/kg increments
- If baby feeding well and settling between feeds, wean as per local policy. If major signs continue, discuss with experienced doctor/ANNP
- Consider need for other medication (e.g. phenobarbital)

Phenobarbital
- For treatment of seizures and for babies of mothers who are dependent on other drugs in addition to opiates and suffering serious withdrawal symptoms, give phenobarbital 20 mg/kg IV loading dose over 20 min, then maintenance 4 mg/kg oral daily
- Unless ongoing seizures, give a short 4–6 day course
- For treatment of seizures, see **Seizures** guideline

Chlorpromazine
- For babies of mothers who use benzodiazepines, give chlorpromazine 1 mg/kg oral 8-hrly if showing signs of withdrawal
- remember chlorpromazine can reduce seizure threshold

Infections
- Follow relevant guidelines for specific situations, such as HIV, hepatitis B or hepatitis C positive mothers [see **Human immunodeficiency virus (HIV)** guideline and **Hepatitis B and C** guideline]
- Refer for BCG immunisation where indicated (see **BCG immunisation** guideline)

DISCHARGE AND FOLLOW-UP

Babies who required treatment
- Ensure discharge planning involving:
- social worker (may not be needed if prescribed for pain relief and no other concerns)
- health visitor
- community neonatal team if treated at home after discharge
- drug rehabilitation team for mother
- If seizures occurred or treatment was required, arrange follow-up in named consultant's clinic or as per local protocol

Babies who did not require treatment
- If no signs of withdrawal, discharge after 96 hr
- Arrange follow-up by GP and health visitor and advise referral to hospital if there are concerns
- Clarify need for any ongoing social services involvement

ADMISSION TO NEONATAL UNIT ● 1/2

- There should be good clinical reasons for admission to NNU
- Avoid unnecessary separation of mother and baby as it affects maternal bonding

Ensure all babies have a newborn infant physical examination (NIPE) within 72 hr of birth AND once they have reached 34^{+0} weeks corrected age as long as they are well enough

CRITERIA FOR ADMISSION FROM LABOUR WARD OR POSTNATAL WARD

Discuss need for admission with senior medical staff

- Clinical condition requiring constant monitoring
- <34 weeks' gestation or birth weight <1700 g
- Unwell baby:
- poor condition at birth requiring prolonged resuscitation for >10 min
- respiratory distress or cyanosis
- apnoeic or cyanotic attacks
- signs of encephalopathy
- jaundice needing intensive phototherapy or exchange transfusion
- major congenital abnormality likely to threaten immediate survival
- seizures
- inability to tolerate enteral feeds with vomiting and/or abdominal distension
- symptomatic hypoglycaemia or hypoglycaemia/not responding to treatment (see **Hypoglycaemia** guideline)
- Neonatal abstinence syndrome requiring treatment (see **Abstinence syndrome** guideline)
- Short-term care while mother admitted to ITU

Procedure

- Manage immediate life-threatening clinical problems (e.g. airway, breathing, circulation and seizures)
- Show baby to parents and explain reason for admission to NNU
- Inform NNU nursing staff that you wish to admit a baby, reason for admission and clinical condition of baby
- Ensure baby name labels present before transfer
- On admission to NNU:
- document relevant history and examination
- complete any local problem sheets and investigation charts
- measure birth weight and head circumference and plot on growth chart
- measure admission temperature
- measure blood pressure non-invasively (cuff)
- institute appropriate monitoring and treatment in conjunction with nursing and senior medical colleagues

Investigations

For babies admitted to NNU, obtain 1 bloodspot on newborn bloodspot screening card and mark as 'pre-transfusion'

Babies <32 weeks/1500 g weight/unwell/ventilated

- FBC
- Blood glucose
- Blood gases
- Clotting screen if clinically indicated (see **Coagulopathy** guideline)
- routine clotting screen is not recommended
- If respiratory symptoms or support given, chest X-ray
- If umbilical lines in place, chest and abdominal X-ray
- If suspicion of sepsis, blood culture and CRP before starting antibiotics and consider lumbar puncture (see **Infection in first 72 hours of life** guideline)

Other babies

- Decision depends on initial assessment and suspected clinical problem (e.g. infection, jaundice, hypoglycaemia etc.), **see relevant guidelines**

IMMEDIATE MANAGEMENT

- Evaluation of baby, including full clinical examination
- Define appropriate management plan and procedures in consultation with tier 2 staff and perform as efficiently as possible to ensure baby is not disturbed unnecessarily
- Aim for examination and procedures to be completed within 1 hr of admission
- If no contraindications, unless already administered, give vitamin K (see **Vitamin K** guideline)
- If antibiotics indicated, give within 1 hr
- Senior clinician to update parents as soon as possible (**certainly within 24 hr**) and document discussion in notes and on **BadgerNet**

Respiratory support

- If required, this takes priority over other procedures
- includes incubator oxygen, high-flow humidified oxygen, continuous positive airway pressure (CPAP) or mechanical ventilation

IV access

- If required, IV cannulation and/or umbilical venous catheterisation (UVC) – see appropriate guidelines in **Practical procedures** section

MONITORING

Use minimal handling

- Cardiorespiratory monitoring through skin electrodes. **Do not use** in babies <26 weeks' gestation
- Pulse oximetry. Maintain SpO_2 as per gestation target values (see **Oxygen saturation targets** guideline)
- Transcutaneous probe for T_cPO_2/T_cPCO_2, if available (especially clinically unstable preterm) (see **Transcutaneous CO_2 and O_2** guideline)
- Temperature
- Blood glucose (see **Hypoglycaemia** guideline)
- If ventilated, umbilical arterial catheterisation (UAC)/peripheral arterial line for monitoring arterial blood pressure and arterial blood gas – see appropriate guidelines in **Practical procedures** section

CRITERIA FOR ADMISSION TO TRANSITIONAL CARE UNIT

The following are common indications for admitting babies to transitional care unit (if available locally), **refer to local guidelines for local variations**

- Small for gestational age, 1.7–2 kg and no other clinical concerns
- Preterm 34–36 weeks' gestation and no other clinical concerns
- Minor congenital abnormalities likely to affect feeding, e.g. cleft lip and palate
- Requiring support with feeding e.g. predicted to require NGT feeds
- Babies of substance abusing mothers (observe for signs of withdrawal)
- Receiving IV antibiotics

AIRWAY CLEARANCE (INTUBATED BABIES) ● 1/2

INTRODUCTION

- Airway clearance essential to:
  - remove secretions
  - maintain airway patency
  - optimise ventilation
- Babies born preterm have a highly compliant chest wall, compliant airways, yet poor pulmonary compliance
- Low muscle tone, small airways, immature mucociliary escalator and immature cough reflex all contribute to challenges in clearing secretions and maintaining lung volume

INDICATIONS

- All intubated and ventilated babies
- Maintain tube patency
- Maintain or improve tidal volumes
- Maintain or reduce peak inspiratory pressures
- Maintain or improve lung compliance
- Reduce risk of atelectasis and collapse
- Reduce risk of endotracheal tube obstruction secondary to retained secretions
- Reduce risk of heterogeneous ventilation distribution
- Maintain or improve oxygen saturations and gas exchange

CONTRAINDICATIONS

- No contraindication for adequate humidification
- Position changes to be made with caution in babies at risk of cardiovascular instability
- Prone position contraindicated in:
  - increased risk of intraventricular haemorrhage (IVH) (e.g. first 72 hr of life, IVH within last 72 hr)
  - umbilical lines *in-situ*
  - distended abdomen
  - following abdominal surgery
  - requiring midline neuro-protective care
  - any baby not monitored
- No absolute contraindication for suction where airway compromised
- Avoid suctioning following administration of surfactant [see **Surfactant replacement therapy – including less invasive surfactant administration (LISA)** guideline]
- Avoid suctioning following pulmonary haemorrhage unless airway obstructed (see **Pulmonary haemorrhage** guideline)

PROCEDURES

Standardised interventions important for all intubated babies include:

- Optimising humidification
  - ensure all ventilated babies have humidifier in the circuit
  - set each humidifier temperature as per manufacturer guidelines
  - ensure minimal rainout (troubleshoot environmental temperature and location of humidifier temperature probe where rainout problematic)
- Optimise positioning plan
  - prioritise variety of positions (upright skin-to-skin, side-lying, supine, prone using prone positioner)
  - target frequent position changes
    - standard 5–6 positions in 24 hr period
  - if significant respiratory compromise (increasing ventilation need, increasing FiO_2, focal chest X-ray changes) consider 8–10 positions in 24 hr period
  - change in body position leads to change in lung function and not just the position on its own
- Good practice suction technique [see **Endotracheal tube (ETT) suctioning** guideline]. Evidence based recommendations reduce risk of complications and optimise outcomes

- only suction when indicated
- 2-person procedure (ensures comfort)
- meticulous hand hygiene before and after patient contact
- ensure condensate emptied from vent tubing before turning and suction
- catheter to be less than ½ diameter of ETT (size of ETT x 2)
  - ensures air flow around catheter during suction procedure
- suction pressure maximum 100 mmHg/13 kPa
  - as low as possible to effectively clear secretions
  - suction duration always <15 sec. Use measured technique [measured length is length of ETT (from connector to end)]
  - if secretions not moving and ETT not at carina, consider 0.5 cm below this length. Do not apply suction on carina
- do not instil sodium chloride 0.9% routinely for suctioning
  - if indicated by obstruction, or secretions not moving through catheter, 0.2–0.3 mL can be instilled to lubricate catheter
- see **Ventilator associated pneumonia** guideline
- do not routinely pre-oxygenate
  - maintain target saturation during procedure by adjusting FiO_2 if required. Avoid hyperoxia (see **Oxygen saturation targets** guideline)

TROUBLESHOOTING

- If standard interventions to optimise airway clearance ineffective consider the following:
- optimise humidification and suction technique as above
- review positioning strategy – aim to increase variety and frequency of turns where respiratory compromise
- consider value of temporarily increasing PIP/MAP before suction, to support increased expiratory flow rate
- if using inline (closed) suction, consider using open suction technique
  - disconnection following an inspiratory breath either via ventilator or Neopuff™ may generate enough expiratory flow to move secretions
- refer to neonatal respiratory physiotherapist for assessment (if available)
- Percussion (chest physiotherapy) historically been used to support secretion clearance
- limited evidence to support continued use in neonatal population
- vigorous percussion without stabilisation of the head in vulnerable extremely preterm babies and poor use of supportive developmental care techniques have previously been linked with IVH and encephaloclastic porencephaly
- competency document available for those who continue to use percussion
- palm cup percussors no longer commercially available
- mucoactives (DNAse/dornase alpha, acetylcysteine, hypertonic sodium chloride) have been used in cases of atelectasis and persistent consolidation and may be helpful (evidence limited)

ANKYLOGLOSSIA (TONGUE-TIE) FOR BREASTFEEDING ● 1/2

Based on NICE IPG 149 and The Cochrane Review for surgical release of tongue-tie for the treatment of tongue-tie in young babies, 2017

INTRODUCTION

- Ankyloglossia (tongue-tie) is the restricted movement of the tongue caused by a short and tight lingual frenulum. These restricted movements may result in difficulties with feeding
- Short lingual frenulum does not always cause problems, and a baby can feed successfully
- Evidence can suggest tongue-tie may cause difficulties in breastfeeding and bottle feeding in some cases
- Feeding support in collaboration with families and babies is essential to determine impact tongue-tie may have
- Frenulotomy is a surgical procedure to release the frenulum so the tongue can move more freely, and feeding may be improved
- Evidence that frenulotomy improves breast feeding is inconsistent
- Individualised feeding assessment and support is crucial for families and babies, and may reduce need for a frenulotomy

INDICATIONS

- A baby with a tongue-tie, where feeding ability is felt to be compromised, may present with several of the following signs:
- inability to open mouth wide to latch to breast
- restricted tongue movement
- difficulty sustaining latch to breast
- biting/chomping on breast
- unsettled behaviour during feeds
- frequent/long feeds
- clicking noises and/or dribbling during feeds
- colic/excessive wind
- reflux (vomiting after feeds)
- excessive early weight loss and faltering growth
- Parent may experience:
- sore/damaged nipples
- nipples that look misshapen/blanched after breastfeeds
- mastitis
- low milk supply
- exhaustion from frequent/constant feeding
- distress and low mood due to feeding not being established

PROCEDURE

- Refer to appropriately trained healthcare professionals and service. They will:
- perform tongue-tie assessment using a recommended assessment tool
  - will include clinical feeding case history and assessment in collaboration with families and appropriate health care professionals
- frenulotomy (if indicated from assessment with consent from families)

Frenulotomy

- Frenulotomy in early infancy is usually performed without anaesthetic (although local anaesthetic is sometimes used)
- Little or no blood loss
- Feeding can be resumed immediately
- Follow-up and ongoing feeding support following procedure is essential

COMPLICATIONS OF PROCEDURE

- May include:
- pain
- bleeding
- recurrence of tongue-tie
- infection

ANKYLOGLOSSIA (TONGUE-TIE) FOR BREASTFEEDING ● 2/2

OUTCOME OF PROCEDURE

- Evidence that division of tongue-tie improves breastfeeding is inconsistent
- NICE 1IPG 49 states “The experts did not agree about how well the tongue-tie procedure worked. Some said that it was difficult to tell whether the improvement in breastfeeding happened as a result of the procedure”
- Cochrane states “In an infant with tongue-tie and feeding difficulties, surgical release of the tongue-tie does not consistently improve infant feeding but is likely to improve maternal nipple pain”

ANORECTAL MALFORMATION ● 1/3

INTRODUCTION

Anorectal malformation (ARM) occurs in 1 in 5,000 neonates; rarely missed in boys, but can be missed in girls. ARMs are associated with other abnormalities including the VACTERL association, chromosomal abnormalities, duodenal atresia and oesophageal atresia

Missing ARM in a girl is usually a breach of duty

BOYS:

- **Figure 1**: anus not present, rectum may have a fistula to the bulbar urethra, prostatic urethra or bladder neck
- **Figure 2**: anus not present, rectum opens via a fistula outside the muscle complex on the perineum
- **Figure 3**: anus not present, meconium passed per urethra

Figure 1: Anus is absent

Figure 2: Fistula opening onto scrotal raphe

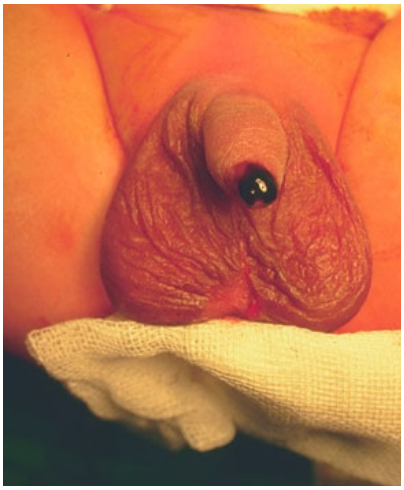


Figure 3: ARM with a fistula to the urinary tract

Once diagnosed boys should be kept nil-by-mouth, have an IVI and urgent transfer for surgery

ANORECTAL MALFORMATION • 2/3

GIRLS

Figure 4:
- Normal urethra, vagina, perineal body, anus
- Anal opening in the muscle complex

Figure 5:
- True anterior anus – rare
- Opening of adequate size with muscle all around, but a very small perineal body
- No surgery required (requires routine referral)

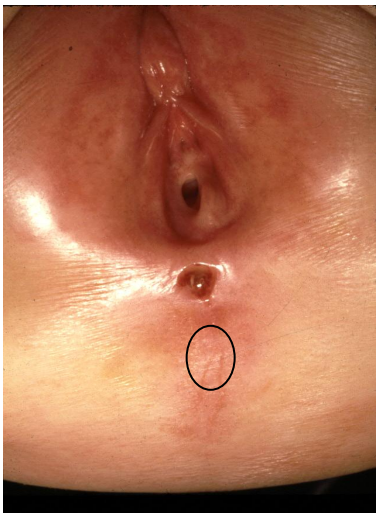


Figure 6:
- Recto-perineal fistula (muscle complex circled)
- Opening is a fistulous connection to the rectum – may not be adequate and is easily missed
- Surgery almost always indicated – refer urgently
- If obstructed, emergency surgery may be required

Figure 7:
- Recto-vestibular fistula
- Opening immediately behind the vagina
- No perineal body
- Emergency referral almost always required – opening will be insufficient to decompress the bowel

- More extreme but rare cases of recto-vaginal fistula and cloaca should be identified at neonatal check
- Always check for ARM when:
- abnormal looking perineum
- delayed/no passage of meconium
- abdominal distension
- bilious vomiting

Non-urgent referral

- Most newborn girls with abnormal perineum require urgent referral; discuss with surgeon and see within a few days if:
  - opening of adequate size to decompress the rectum **and**
  - plenty of meconium being passed **and**
  - no distension or vomiting

EXAMINATION

- Full physical examination
- look for:
  - dysmorphic features
  - cardiac anomalies
  - limb anomalies
  - abdominal distension
- describe the perineum

Caution

- Presence of meconium in nappy **does not** exclude an ARM, as neonate may still pass meconium through a fistula
- Always clean the perineum and establish that a normally sited anus is present

MANAGEMENT

- Depends on size of any opening – see above
- If obstructed:
  - nil-by-mouth, 8 Fr NGT, empty stomach by aspirating 4-hrly with a syringe and place NGT on free drainage by connecting to a bile bag
- Insert IV cannula and obtain blood for FBC, U&E, glucose and blood cultures
- Start maintenance IV fluids (see **Intravenous fluid therapy** guideline)
- Give broad spectrum antibiotics
- Give vitamin K IM (see **Vitamin K** guideline)
- Collect pre-transfusion bloodspot and send with baby to surgical centre
- Replace nasogastric losses mL-for-mL using sodium chloride 0.9% with 10 mmol potassium chloride in 500 mL IV
- Chest X-ray to confirm position of NGT, assess vertebral anomalies and cardiac outline
- Supine abdominal X-ray looking for dilated bowel/associated bowel atresia vertebral anomalies
  - combined chest and abdominal X-ray is suitable as an alternative
- Take photographs of baby for parents if required

Referral

- Refer to paediatric surgical team
- Complete nursing and medical documentation for transfer and arrange electronic transfer of any X-rays taken. Ensure you have mother's name and telephone contact details (including ward details if she is still an inpatient). Surgeon will require verbal telephone consent if an operation is required and an individual with parental responsibility is not able to attend surgical unit at appropriate time
- Inform surgical unit staff when baby ready for transfer. Have available: name, gestational age, weight, ventilatory and oxygen requirements (if applicable) and mother's name and ward (if admitted)
- Obtain sample of mother's blood for crossmatch
  - sample tube must be clearly hand written and labelled with mother's name, date of birth, NHS number, and date and time of collection
  - complete form
  - add baby's details to ensure it is clear that sample relates to mother of baby being transferred (this information is required by surgical unit blood bank)

USEFUL INFORMATION

- https://bwc.nhs.uk/paediatric-surgery-treatments
- https://www.e-lfh.org.uk/programmes/paediatric-surgery/

ANTENATAL ULTRASOUND ABNORMALITIES ● 1/2

DEFINITION

- Any lesion identified antenatally in the fetus (e.g. renal pelvic dilatation, hypoplastic left heart)
- Any maternal factor identified antenatally that could affect baby after delivery (e.g. anhydramnios from preterm prolonged rupture of membranes, maternal antibodies causing fetal anaemia)

COUNSELLING BEFORE DELIVERY

- Abnormality detected in a local unit may require referral to regional fetal medicine centre
- All affected pregnancies will have detailed individualised plans for management of baby by ~~consultant~~ neonatologist, including place of delivery
- As some lesions are progressive (e.g. hypoplastic left heart syndrome, gastroschisis), the situation can change and information from the obstetric team can alter over time. Discuss all affected pregnancies at the combined fetomaternal meeting until delivery
- Offer neonatal counselling to all women whose pregnancy has been affected by major lesions, to discuss the impact of the identified lesion on quality of life, including possible disabilities, investigations and surgery, and post-delivery plan

Cleft lip and/or palate

- Obstetric team to refer to regional multidisciplinary cleft palate team, who will counsel parents, communicate plans for delivery and provide postnatal support for baby

Hypoplastic left heart syndrome or other presumed duct-dependent lesions

- Obstetric team to refer to regional fetal cardiologist, who will counsel parents and, where appropriate, confirm diagnosis and provide a plan of action, including most appropriate unit for delivery

Congenital diaphragmatic hernia

- Obstetric team to refer all cases to tertiary fetal medicine team at time of diagnosis
- Amniocentesis may be performed before referral where this is offered (Birmingham or Liverpool) who will counsel, monitor and arrange delivery in the NICU

Ventriculomegaly

- Obstetric team to refer to fetal medicine team, who will counsel parents, consider further testing, e.g. fetal MRI/amniocentesis/screening for fetal infections, and plan for delivery (timing and mode)

Fetal anaemia due to alloimmunisation

- Obstetric team to refer to tertiary fetal medicine team who will counsel parents, and where appropriate, perform in utero fetal blood transfusion and provide plan of action including timing and most appropriate unit for delivery

Renal pelvis dilatation/hydronephrosis

- Obstetric team to refer to fetal medicine team who will counsel parents, consider further testing e.g. amniocentesis, and plan postnatal investigations

Twin-to-twin transfusion syndrome

- Obstetric team to refer to tertiary fetal medicine team who will counsel parents and where appropriate perform in utero procedures (laser ablation) and provide plan of action including timing and most appropriate unit for delivery

Known genetic disorder (e.g. inborn error of metabolism)

- Obstetric team to refer to fetal medicine team who will counsel parents, involve clinical genetics team for further counselling, consider further testing e.g. amniocentesis and plan postnatal evaluation and treatment

MANAGEMENT AFTER DELIVERY

- For minor lesions, follow appropriate guideline and inform senior staff and parents
- For other lesions, follow written plan made by senior staff before delivery, including need to contact seniors and specialist staff in regional referral centre before and after delivery
- Communicate any new information obtained after birth to consultant as this may change the plan of care required
- Maintain regular contact with specialist teams as indicated by them
- Arrange postnatal transfer if required when bed available
- Keep parents informed of actions taken and contact from specialist teams

- Consider syndrome for babies with >1 lesion, discuss with senior staff as soon as possible
- When available and if not issued antenatally, provide written information from 'Contact a family' book or www.cafamily.org.uk/

Specific lesions
See **Urinary tract abnormalities diagnosed antenatally, Gastroschisis, Congenital diaphragmatic hernia** and **Congenital heart disease: duct dependent lesions** guidelines

APNOEA AND BRADYCARDIA● 1/2

RECOGNITION AND ASSESSMENT

Apnoea

- Pause(s) in breathing >20 sec (or less, when associated with bradycardia or cyanosis)

Bradycardia

- Heart rate <100 bpm, associated with desaturation

Types

Central

Caused by poorly developed neurological control

- Respiratory movements absent

Obstructive

- Caused by upper airway obstruction, usually at pharyngeal level
- Respiratory movements continue initially but then stop

Mixed

- Initially central, followed by obstructive apnoea

Significance

- Most babies born <34 weeks' gestation have primary apnoea of prematurity (PAP). Hence babies born <34 weeks should have SpO_2 monitoring until ≥34 weeks' post conceptional age (PCA)
- multiple aetiologic factors can exacerbate apnoea in preterm babies
- sudden increase in frequency warrants immediate action
- Consider causes other than apnoea of prematurity if occurs:
- in term or near-term baby (>34 weeks' gestation)
- on first day after birth in preterm baby
- onset of apnoea after aged 7 days in a preterm baby

Causes

Infection

- Sepsis
- Necrotising enterocolitis
- Meningitis

Respiratory

- Inadequate respiratory support
- Upper airway obstruction
- Surfactant deficiency

CNS

- Intracranial haemorrhage
- Seizure
- Congenital malformations

CVS

- Patent ductus arteriosus

Other

- Metabolic abnormalities, especially hypoglycaemia
- Haematological: anaemia
- Inherited metabolic disorders e.g. non-ketotic hyperglycinaemia
- Consider physiological response to stress from handling/environmental factors. Ensure appropriate developmental care (see **Developmental care** guideline)

MANAGEMENT

Terminate episode

- If apnoea not self-limiting (clinician to agree threshold to intervene), perform the following in sequence to try to terminate episode:
- ensure head in neutral position
- stimulate baby by tickling feet or stroking abdomen

- if aspiration or secretions in pharynx suspected, apply brief oropharyngeal suction
- face mask ventilation
- emergency intubation
- Once stable, perform thorough clinical examination to confirm/evaluate cause

Screen for sepsis

- If apnoea or bradycardia increasingly frequent or severe, screen for sepsis as apnoea and bradycardia can be sole presenting sign

TREATMENT

- Treat specific cause, if present
- Primary apnoea of prematurity is a diagnosis of exclusion and may not require treatment unless pauses are:
- frequent (>8 in 12 hr) or
- severe (>2 episodes/day requiring positive pressure ventilation)

Pharmacological treatment

- Caffeine citrate 20 mg/kg loading dose oral/IV (over 30 min) followed, after 24 hr, by maintenance dose of 5 mg/kg oral/IV (over 10 min) once daily, increasing to 20 mg/kg if required until 34 weeks' PCA
- If desaturations and bradycardias persist, may continue beyond 34 weeks' PCA. If so, review need for treatment regularly

Non-pharmacological treatment

- CPAP, SiPAP/BiPAP [see **Ventilation: continuous positive airway pressure (CPAP)** guideline]
- If above fails, intubate and ventilate

ARTERIAL LINE INSERTION • 1/2

PERIPHERAL ARTERIAL LINES

Indications

- Frequent monitoring of blood gases
- Direct monitoring of arterial blood pressure
- Exchange transfusion (peripheral venous and arterial catheters 'continuous' technique) or partial exchange transfusion

Contraindications

- Bleeding disorder
- Inadequate patency of ulnar artery on transillumination or failed Allen's test (if cannulating radial artery) or vice-versa
    - Pre-existing evidence of circulatory insufficiency in limb
- Local skin infection
- Malformation of limb being considered for line insertion

Possible sites of arterial entry

- Radial (most used); the only procedure discussed in this guideline
- Posterior tibial
- Dorsalis pedis

EQUIPMENT

- Gloves
- Cleaning solution as per unit policy
- 24 G cannula
- T-connector with Luer lock
- Adhesive tape
- Splint
- Sodium chloride 0.9% flush in 2 mL syringe, primed through T-connector
- Transillumination fibre-optic light source
- 3-way tap

PROCEDURE USING RADIAL ARTERY

Preparation

- Wash hands
- Check patency of ipsilateral ulnar artery using Allen's test and proceed only if patent
- Put on gloves
- Extend baby's wrist with palm of hand upwards
- Transilluminate radial artery with fibre-optic light source behind baby's wrist or palpate pulse
- Clean skin with antiseptic cleaning solution

Procedure

- Enter artery with 24 G cannula just proximal to wrist crease at 25–30° angle
- Remove stylet from cannula and advance cannula into artery
- Connect cannula to T-connector primed with sodium chloride 0.9%, and flush gently
- Secure cannula with tape, ensuring fingers are visible for frequent inspection, and apply splint
- Connect T-connector to infusion line (sodium chloride 0.9% or 0.45% with heparin 1 unit/mL), with 3-way tap *in situ* for blood sampling

Documentation

- Document clearly in notes all attempts at cannulation, including those that are unsuccessful

AFTERCARE

Monitor

- Inspect distal digits regularly for circulatory status; if blanching does not recover after 5 min, discuss further management with consultant
- Avoid excessive hyperextension of wrist, as this can result in occlusion of artery
- Ensure a continuous pressure waveform tracing is displayed on monitor screen at all times; if flushing line does not restore lost tracing, change position of limb/dressing

ARTERIAL LINE INSERTION ● 2/2

Usage

- Do not administer rapid boluses of fluid as this can lead to retrograde embolisation of clot or air; use minimal volume when flushing after sampling and inject slowly
- Use cannula only for sampling or removal of blood during exchange transfusion, and infuse sodium chloride 0.9% or 0.45% with heparin 1 unit/mL
- Remove cannula as soon as no longer required

Removal

- Aseptic removal of arterial line: apply pressure for ≥5 min (longer if coagulopathy/low platelets), until no bleeding
- dressings do not prevent bleeding or bruising
- do not send tip for culture routinely

COMPLICATIONS

- Thromboembolism/vasospasm/thrombosis
- Blanching and partial loss of digits (radial artery)
- Necrosis
- Skin ulceration
- Reversible occlusion of artery
- Extravasation of sodium chloride infusate
- Infection (rarely associated with line infection)
- Haematoma
- Haemorrhage
- Air embolism

ARTERIAL LINE SAMPLING ● 1/2

INDICATIONS
- Blood gas analysis
- Biochemical/and haematological investigations

CONTRAINDICATIONS
- Blood drawn from arterial line not suitable for bloodspot screening
- Blood from arterial line can give inaccurate coagulation studies result if not taken correctly – ensure taken in appropriate way with a larger volume of blood withdrawn from the dead space

COMPLICATIONS
Haemorrhage
- Ensure all connections are secure, Luer locks tight and 3-way taps appropriately adjusted

Infection
- Maintain sterile technique during sampling to reduce risk of infection

Arterial spasm
- Limb appears blanched. Stop procedure and allow time for recovery. Warming of opposite limb can elicit reflex vasodilatation
- Using warmed fluids as flush may minimise artery spasm

Thromboembolism
- Flush catheter with sodium chloride 0.9% 0.5 mL each time sample taken. If catheter not sampling, clot formation may be in progress. Request urgent senior review of arterial line for a prompt decision about removal

Inaccuracy of blood gas results
- Analyse sample immediately. After blood is withdrawn from an artery, it continues to consume oxygen. Ensure all air in syringe expelled immediately to prevent inaccurate oxygen levels
- Excess heparin in syringe can result in a falsely low pH and $PaCO_2$
- Do not use if air bubbles in sample – take fresh specimen

EQUIPMENT
- Gloves
- Paper towel
- Alcohol swabs x 2
- Syringes
  - 2 mL syringe (A) for clearing line
  - 2 mL syringe (B) for other blood samples as necessary
  - 1 mL syringe (C) pre-heparinised for blood gas analysis
  - 2 mL syringe (D) containing 0.5–1 mL of sodium chloride 0.9%
- Appropriate blood sample bottles and request forms

PREPARATION AND PROCEDURE
Preparation
- Record SpO_2 and $TcCO_2$ at time of taking blood to allow comparison with blood gas if performed
- Wash hands and put on gloves
- Place paper towel beneath 3-way tap collection port (maintain asepsis by non-touch technique rather than sterile gloves and towel)
- Ensure 3-way tap closed to side port

Procedure
- Remove Luer lock cap, clean with alcohol swab and allow to dry, or prepare bioconnector
- Connect 2 mL syringe (A)
- Turn 3-way tap so it is closed to infusion and open to syringe and arterial catheter
- Withdraw 2 mL blood slowly. It must clear the dead space
- If bioconnector not being used, turn 3-way tap so it is closed to arterial catheter to prevent blood loss from baby
  - if bioconnector used, do not turn 3-way tap until end of procedure

- Attach appropriate syringe (B/C) needed for required blood sample
- If bioconnector not being used, turn 3-way tap to open to syringe and arterial catheter and withdraw required amount of blood for blood samples. Do not withdraw more than required amount
- If bioconnector not being used, turn 3-way tap off to arterial catheter in between syringes B and C if both required, after taking required samples with syringes
- Reattach syringe (A) after any air bubbles expelled
- Slowly return to baby any blood in line not required for samples
- If bioconnector not being used, turn 3-way tap off to arterial catheter
- Attach syringe (D) of sodium chloride 0.9%
- If bioconnector not being used, turn 3-way tap so it is open to syringe and arterial line. Check for air bubble in syringe and flush arterial line to ensure clear of blood
- Turn 3-way tap so it is closed to syringe, remove syringe (D), swab port with alcohol wipe and cover with Luer lock cap
- Record amount of blood removed and volume of flush on baby's daily fluid record

AFTERCARE

- Ensure all connections tight and 3-way tap turned off to syringe port to prevent haemorrhage
- If sampling from umbilical arterial catheter, ensure lower limbs are pink and well perfused on completion of procedure
- If sampling from peripheral arterial line, check colour and perfusion of line site and limb housing arterial line
- Ensure line patency by recommencing infusion pump
- Before leaving baby, ensure arterial wave form present and all alarms set

BABIES BORN EXTREMELY PREMATURELY: 22^{+0}–26^{+6} WEEKS GESTATION ● 1/2

INTRODUCTION

- Outcomes for babies born very preterm improve with each additional week of gestational age; and have improved over time for any given gestation (see EPICure studies http://www.epicure.ac.uk
- **Make all efforts** to enable discussions between consultant-led obstetric and neonatal/paediatric teams and parents-to-be to take place **before** the birth of the baby
- See **BAPM framework for practice** https://www.bapm.org/resources/80-perinatal-management-of-extreme-preterm-birth-before-27-weeks-of-gestation-2019 to inform discussions and make an individualised clearly documented plan for the management of the baby
- Once the baby is born, further management decisions should be made in the baby's best interests, taking into account:
  - prognostic factors
  - previous discussions between obstetric and neonatal teams and parents-to-be
  - clinical condition at birth
  - response to stabilisation/resuscitative efforts
- In the event of imminent delivery before discussions have taken place (if fetal heart heard during labour), call neonatal team to attend delivery and request urgent neonatal/paediatric consultant assistance

MANAGEMENT

- Using the prognostic features from **BAPM Framework for practice**, babies will fall into one of the following groups: extremely high risk; high risk; or medium risk of dying/surviving without a good quality of life

Extremely high risk

- Babies with >90% chance of either dying/surviving with severe impairment if active care is instigated e.g.:
  - babies 22^{+0}–22^{+6} weeks' gestation with unfavourable risk factors
  - some babies 23^{+0}–23^{+6} weeks' gestation with unfavourable risk factors, including severe fetal growth restriction
  - (rarely) babies ≥24^{+0} weeks' gestation with significant unfavourable risk factors, including severe fetal growth restriction

High risk

- Babies with 50–90% chance of either dying or surviving with severe impairment if active care instituted, e.g.:
  - babies 22^{+0}–23^{+6} weeks' gestation with favourable risk factors
  - some babies ≥24^{+0} weeks' gestation with unfavourable risk factors and/or co-morbidities

Moderate risk

- Babies with <50% chance of either dying/surviving with severe impairment if active care instituted e.g.:
  - most babies ≥24^{+0} weeks' gestation
  - some babies at 23^{+0}–23^{+6} weeks' gestation with favourable risk factors

MANAGEMENT AT BIRTH

- Consultant neonatologist/paediatrician should ideally be present at delivery of babies <27 weeks' gestation where survival-focused care may be attempted

Extremely high risk

- Palliative (comfort-focused) care would be in best interests of the baby and life-sustaining treatment should not be offered
  - this should be compassionately explained to the parents by the perinatal team
- Generally neonatal team would not attend the birth (however may be helpful for individual families – offer if appropriate)

High risk

- For these babies it is uncertain whether survival-focused management is in the best interests of the baby and their family
- Counsel parents carefully; parental wishes should inform a joint decision to provide either survival-focused or comfort-focused treatment
- Senior neonatal clinician (ideally known to the parents) will attend the birth if at all possible, to lead/oversee implementation of agreed approach

BABIES BORN EXTREMELY PREMATURELY: 22^{+0}–26^{+6} WEEKS GESTATION ● 2/2

Counsel parents that the plan for care may need to change based on the clinical condition of the baby before, at or after birth, or subsequently in NICU

Active (survival focused) neonatal management

- Stabilisation and support for transition to be carried out by/under direct supervision of most senior member of neonatal/paediatric team available (ideally team will be experienced in stabilisation of extremely preterm babies and led by consultant neonatologist)
- Team should be aware of parental wishes, but when the baby is born in **unexpectedly poor or unexpectedly good** condition, it is reasonable for attending neonatologist to proceed with care in the baby's best interests
- Use optimal cord management and appropriate thermoregulation
- Care should be taken not to over distend lungs when supporting respiratory transition, CPAP may be successfully used in babies from 24^{+0} weeks' gestation
- If no response to mask ventilation **and** any doubt around adequacy of ventilation, intubate and administer surfactant [see **Surfactant replacement therapy – including less invasive surfactant administration (LISA) technique** guideline]
- If the baby does not respond to stabilisation/resuscitative efforts, most senior attending professional to decide if/when attempts should stop
- absent heart rate/severe bradycardia despite effective resuscitation efforts for more than a few minutes is associated with very poor outcome in extremely preterm babies
- Stabilisation normally undertaken in same room as parents
- offer parents opportunity to see, touch, hold and photograph their baby
- Following successful stabilisation of the baby, the mother should be supported to express breast milk as early as possible (see **Breastfeeding** guideline), with ongoing facilitation of parental contact and family involvement

Palliative (comfort focused) neonatal management

- Aim is to support the parents and their dying baby, and to avoid interventions that may cause discomfort, pain or separation of the baby from the parents
- Care to be delivered in most appropriate location for the family (may not be NNU, and does not require in utero transfer of mother)
- For some families the presence of a senior neonatologist/paediatrician at delivery may be helpful
- all involved should understand that respiratory support will not be provided
- Give opportunities and support parents in creating positive memories of their baby
- Offer parents the opportunity to hold and spend as much time as they wish with their baby in a quiet and private location
- In the unlikely scenario of the baby being born in much better condition than expected, palliative management may need to be reconsidered

PARENT INFORMATION

- See https://www.bapm.org/resources/80-perinatal-management-of-extreme-preterm-birth-before-27-weeks-of-gestation-2019 **Appendix 4: Helping parents to understand extreme preterm birth**

BCG IMMUNISATION ● 1/3

See also **Tuberculosis (investigation and management following exposure in pregnancy)** guideline

INDICATIONS

- All babies (aged ≤12 months) with a parent or grandparent who was born in a country where the annual incidence of TB is ≥40/100,000

Countries with incidence of TB ≥40/100,000

Afghanistan	Ecuador	Korea DPR	Niger	Taiwan
Algeria	El Salvador	Korea (Rep. of)	Nigeria	Tanzania
Angola	Equatorial Guinea	Kyrgyzstan	Niue	Thailand
Azerbaijan	Eritrea	Lao PDR	Northern Mariana Islands	Timor-Leste
Bangladesh	Eswatini	Lesotho	Pakistan	Turkmenistan
Benin	Ethiopia	Liberia	Palau	Tuvalu
Bhutan	Fiji	Libya	Papua New Guinea	Uganda
Bolivia	Gabon	Lithuania	Paraguay	Ukraine
Botswana	Gambia	Madagascar	Peru	Uzbekistan
Brazil	Georgia	Malawi	Philippines	Vanuatu
Brunei	Ghana	Malaysia	Romania	Venezuela
Burkina Faso	Greenland	Mali	Russia	Vietnam
Burundi		Marshall Islands	Rwanda	Yemen
Cambodia	Guinea	Mauritania	Sao Tome and Principe	Zambia
Cameroon	Guinea-Bissau	Micronesia	Senegal	Zimbabwe
Cape Verde	Guyana	Moldova	Sierra Leone	
Central African Republic	Haiti	Mongolia	Singapore	
Chad	Hong Kong	Morocco	Solomon Islands	
China	India	Mozambique	Somalia	
Congo	Indonesia	Myanmar	South Africa	
Congo DR	Iraq	Namibia	South Sudan	
Côte d'Ivoire	Kazakhstan	Nauru	Sri Lanka	
Djibouti	Kenya	Nepal	Sudan	
Dominican Republic	Kiribati	Nicaragua	Tajikistan	

https://worldhealthorg.shinyapps.io/tb_profiles

BCG vaccine to be given to eligible baby:

- Once aged 28 days
- On receipt of screen negative severe combined immune deficiency (SCID) result (or 'SCID not offered' result)

Tuberculin testing not necessary aged <6 yr unless baby has been in recent contact with TB or has resided in high-incidence country for >3 months

CONTRAINDICATIONS

- SCID screen positive or screen performed and result pending
- Temperature >38°C or acutely unwell
- Severe eczema (give at suitable lesion-free site)
- Baby in household where an active TB case suspected or confirmed, see **Tuberculosis (investigation and management following exposure in pregnancy)** guideline
- Immunodeficient or on high-dose corticosteroids
  - defer BCG until 3 months after stopping corticosteroids if given prednisolone 1 mg/kg/day for >2 weeks, 2 mg/kg/day for 1 week, (or equivalent doses of another corticosteroid, e.g. dexamethasone 150 micrograms = prednisolone 1 mg)
- Maternal immunosuppressive treatment during pregnancy or breastfeeding
- Biologics including anti-TNFα (e.g. etanercept, infliximab, adalimumab) for conditions such as arthritis or inflammatory bowel disease, postpone BCG until aged 6 months
  - immune-modulation therapy for treatment of COVID in pregnancy e.g. tocilizumab and sarilumab, postpone BCG until aged 6 months
- HIV positive, living in UK
  - if mother HIV positive and high risk of HIV transmission [see **Human immunodeficiency virus (HIV)** guideline] and exclusively formula feeding, give vaccine only after baby is confirmed HIV uninfected at aged 12–14 weeks
  - if mother HIV positive and very low risk or low risk of HIV transmission [see **Human immunodeficiency virus (HIV)** guideline] BCG can be given to baby when indicated
  - if high risk of TB exposure and maternal HIV viral load <50 copies/mL after 36 weeks' gestation, BCG can be given at birth

- encourage maternal HIV testing but do not withhold BCG if mother declines testing unless mother from sub-Saharan Africa, in which case refer to HIV team for counselling about testing

SPECIAL CASES

- No need to delay routine vaccinations
- BCG can be given simultaneously with other vaccines [including rotavirus vaccine oral or palivizumab (Synagis®) (IM but not in same arm)]
- no further immunisation should be given in arm used for BCG immunisation for ≥3 months due to risk of regional lymphadenitis
- if not given at same time, leave 4 weeks before giving other injectable live vaccines
- Premature babies to have their BCG at appropriate chronological age
- Do not delay for minor illnesses without fever/systemic upset

PROCEDURE

Consent

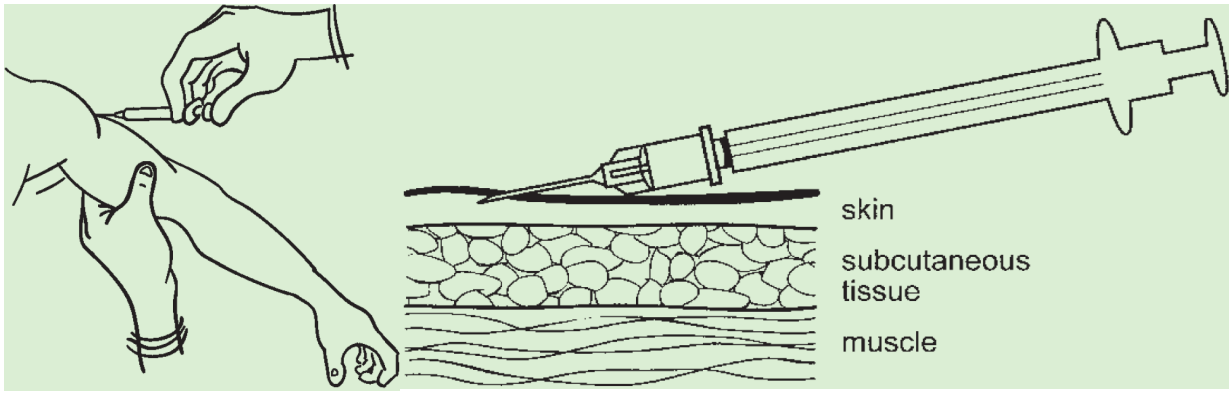
- Midwife to record at booking if risk factor present
- Postnatal check for risk factor
- Ensure baby within inclusion group
- Give mother information on vaccine
- Give appropriate language leaflet **TB, BCG vaccine and your baby,** available from https://www.gov.uk/government/publications/tb-bcg-and-your-baby-leaflet order line: 0300 123 1002
- Department of Health guidelines state written consent is not required but follow local practice

Reconstitution

- Use only solvent provided with BCG vaccine AJV for reconstitution
- Using a syringe fitted with a long needle, transfer volume of solvent given on label to the vial
- Carefully invert vial a few times to completely resuspend the lyophilised BCG. **DO NOT SHAKE**
- Use product immediately after reconstitution

Injection

Only staff trained to give intradermal injections to give BCG



- **Dose: 0.05 mL via intradermal injection (Note: vial contains 20 doses)**
- Hold arm at 45° to body
- At insertion of deltoid muscle near middle of left upper arm
- If skin is clean, no further cleaning is necessary
- If skin is visibly dirty, clean with soap and water
- Stretch skin between thumb and forefinger
- Introduce needle bevel upwards approximately 2 mm into superficial layers of dermis almost parallel to skin
- Injection to be given slowly
- If considerable resistance not felt, remove needle and reinsert before giving more vaccine
- Correctly given intradermal injection results in a tense blanched bleb

DOCUMENTATION

- Enter on BCG page in online Child Health Record or in Red Book and tear out yellow copy for Child Health

SEQUELAE

- Scar
  - within 2–6 weeks a small papule will appear
  - sometimes this ulcerates and can ooze
  - site need not be protected from water
  - do not cover with an impervious dressing
  - can take several months to heal
  - occasionally persists as keloid (particularly if given superior to insertion of deltoid)
- Adenitis:
  - a minor degree of adenitis can occur in the weeks following BCG
  - no treatment indicated
- Rare sequelae:
  - local abscess
  - chronic suppurative lymphadenopathy
  - disseminated disease, if immunocompromised
  - osteitis, refer to infectious diseases specialist

Refer to paediatric TB team if:

- Severe local reactions
  - abscesses or drainage at the injection site **or**
  - regional suppurative lymphadenitis with draining sinuses

Refer disseminated BCG infection to paediatric TB specialist

BLOOD GROUP INCOMPATIBILITIES (INCLUDING RHESUS DISEASE) ● 1/2

Aim to avoid kernicterus and severe anaemia
Keep consultant in charge informed

POSTNATAL MONITORING

Babies at risk

- Those with mothers with known blood group antibodies including:
- D (Rhesus), c, C, s, E, e, Duffy
- anti-D and anti-c can cause severe disease
- anti-C, anti-E and anti-e can cause mild-moderate disease
- Kell: causes bone marrow suppression in addition to haemolysis

Management of babies at risk of haemolysis

- **Antenatally:** prepare a plan based on antibody titres, middle cerebral artery Dopplers and evidence of hydrops. In severely affected cases, order blood in advance for exchange transfusion
- send cord blood **urgently** for Hb, blood group, direct Coombs test (DCT), Kleihauer test and **serum bilirubin** in all babies who have had an in-utero blood transfusion (IUT)
- chase results
- If pale with abnormal cardiorespiratory signs (e.g. tachycardia), admit to NNU
- Be aware of limitation of skin colour in babies with black and brown skin
- If baby has positive DCT or had an IUT (regardless of DCT and blood group) discuss with middle grade or consultant
- If cord bloods not available, check baby's blood immediately for bilirubin, Hb and DCT
- Monitor serum bilirubin, usually at 6-hrly intervals until level is both stable/falling **and** 2 consecutive values are lower than treatment threshold by at least 50 micromol/L
- Plot bilirubin values on NICE gestational age-specific charts (see below)
- Keep parents informed
- Discuss progress regularly with tier 2 staff
- Use gestational age-specific charts to determine whether baby needs phototherapy or exchange transfusion
- If baby has negative DCT and did not have IUT, no further action required; baby is not affected

Management of babies with haemolysis diagnosed or suspected postnatally

- Babies with:
- positive DCT, manage as above
- red cell enzyme defect, inform consultant

PHOTOTHERAPY

Indications/treatment thresholds
Refer to NICE jaundice guideline table and treatment charts (http://www.nice.org.uk/guidance/CG98 under 'Tools and resources' then 'CG98 Neonatal Jaundice: treatment threshold graphs')

Prophylactic phototherapy (e.g. from birth) is not beneficial

DO NOT subtract the direct/conjugated bilirubin value from the total

- Inform middle grade when a baby requires phototherapy

Management

- Plot bilirubin values on appropriate gestation NICE treatment chart
- Administer phototherapy (see **Jaundice** guideline)
- Check bilirubin 6 hr after onset of phototherapy and at least 6-hrly until level is both stable/falling **and** 2 consecutive values are lower than the treatment threshold by at least 50 micromol/L

INTRAVENOUS IMMUNOGLOBULIN (IVIG)

Always discuss indications with consultant

Indications for IVIG use in isoimmune haemolytic anaemia

Indication	Bilirubin level
IVIG indication for rapidly rising bilirubin level as recommended by NICE 2010	Rising at >8.5 micromol/L per hour despite intensive phototherapy [4 light sources used at correct distance (see **Table** in **Jaundice** guideline)]
Second dose of IVIG	If bilirubin continues to rise rapidly as above (see **Table** in **Jaundice** guideline), a single repeat dose of IVIG can be given >12 later

Dose and administration

- Complete immunoglobulin request form (this is a red indication for use; please tick relevant box on form)
- 500 mg/kg over 4 hr (see **Neonatal Formulary**)

EXCHANGE TRANSFUSION

Always discuss indications with consultant

- See **Exchange transfusion** guideline

BEFORE DISCHARGE

- Check discharge Hb, bilirubin and review need for folic acid (see **Jaundice** guideline for dose)

FOLLOW-UP AND TREATMENT OF LATE ANAEMIA

Babies with weakly positive or 1–2+ DCT

- If baby did not require treatment for jaundice do not give folic acid, no follow-up is needed
- If baby required treatment for jaundice follow guidance below
- If uncertain about the need for follow-up, discuss with consultant

All babies with haemolytic anaemia

- Arrange Hb check and review at aged 2 weeks
- Discuss results urgently with neonatal consultant
- dependent on rate of fall of Hb from discharge Hb, frequency of Hb checks planned (may need to be as often as weekly)
- for babies who had IUT, IVIG or exchange transfusion, follow up with Hb check every 2 weeks initially, and until aged 3 months; thereafter arrange developmental follow-up (see below)
- for all other babies who had >2+ DCT, review with Hb check at 2 and 6 weeks; once Hb stable discharge from follow-up and discontinue folic acid if this has been prescribed

Indication for top-up transfusion for late anaemia

- Symptomatic anaemia and or Hb <75 g/L

Ongoing neurodevelopmental follow-up and hearing test

- Arrange for any baby:
- with definite red cell anomalies
- who has undergone an exchange transfusion
- who has had an IUT
- who required IVIG
- with serum bilirubin at or above exchange transfusion threshold

BLOODSPOT SCREENING ● 1/2

INTRODUCTION

- Screen babies on day 5 of age (date of birth = day 0) for the following conditions:
  - sickle cell disease
  - phenylketonuria (PKU)
  - congenital hypothyroidism (CHT)
  - cystic fibrosis
  - medium chain acyl co-A dehydrogenase deficiency (MCADD)
  - maple syrup urine disease (MSUD)
  - isovaleric acidaemia (IVA)
  - glutaric aciduria type 1 (GA1)
  - homocystinuria (HCU)
  - severe combined immunodeficiency (SCID)

Obtain pre-transfusion bloodspot samples as previous blood transfusions can falsify results

TIMING

- Co-ordinate with other tests when possible to minimise invasive procedures

If transfused before day 5

- Collect first bloodspot card before transfusion
  - fill 1 circle
  - mark card 'pre-transfusion'
- Collect second bloodspot card at aged 5–8 days and ≥72 hr after blood transfusion
  - fill 4 circles
  - record whether plasma or red cells transfused
- Staple pre-transfusion and second bloodspot card together and send to West Midlands screening centre via courier service after validation check
- If baby has not received a blood transfusion the pre-transfusion bloodspot card can be discarded appropriately

Multiple transfusions between aged 5–8 days

- Collect 4 bloodspots within this window. Complete with as much time-lapse as possible from any transfusion
- If ≤3 clear days between the last transfusion and routine sample, a repeat sample to be taken ≥3 clear days after the last transfusion

No transfusions before day 5

- Collect routine bloodspot card at day 5
  - fill 4 circles and send to West Midlands screening centre via courier service after validation check, irrespective of milk feeds or gestational age

Preterm babies ≤31 weeks and 6 days will require repeat sample at 28 days or discharge home, whichever is the sooner, for CHT. Collect 2 bloodspots. Mark the sample 'CHT preterm' and write the gestational age on the card

CONSENT AND INFORMATION

- Person undertaking procedure must:
  - offer parents an informed choice about screening for their baby, to gain consent and prepare them for the blood sampling procedure
  - provide national pre-screening leaflet at least 24 hr before procedure
  - parents must understand that they are consenting to storage of residual bloodspots, these can be used for:
    - checking screening results
    - monitoring and improving the screening programme and health research that does not identify babies
- It is mandatory to include baby's NHS number on the bloodspot card
- If screening declined:
  - for all conditions – send completed card to screening laboratory (without blood sample) clearly marked DECLINE – ALL CONDITIONS

- inform GP, health visitor and Child Health Records Department, in writing, of conditions baby not screened for
  - template letters available from: https://www.gov.uk/government/publications/declined-newborn-blood-spot-screening-template-letters

Further information

Detailed information regarding the UK Newborn screening programme can be sourced from:

- Newborn bloodspot screening programme handbook: https://www.gov.uk/government/publications/health-professional-handbook-newborn-blood-spot-screening
- Standards for NHS newborn bloodspot screening: https://www.gov.uk/government/publications/standards-for-nhs-newborn-blood-spot-screening
- Newborn bloodspot screening sampling guidelines: https://www.gov.uk/government/publications/newborn-blood-spot-screening-sampling-guidelines

BOTTLE FEEDING IN THE NEONATAL UNIT ● 1/2

INTRODUCTION

- Babies may show signs they are ready to try a bottle feed around 34–36 weeks' gestation, but for some babies this will be later
- Greater maturity required in comparison to breastfeeding (**https://www.teamwmcn.nhs.uk/neonatal-guidelines**)
- Parents are essential and equal partners and should be empowered to take part in all aspects of their baby's care

AIM

- Protect breastfeeding when this is parental choice
- Facilitate cue based and responsive feeding approach
- Positive bottle feeding experience following baby's cues and developmental abilities
- To mitigate persistent feeding and/or swallowing difficulties e.g. aspiration and/or sensory based feeding difficulties
- Essential to discuss benefits of direct breastfeeding, and potential impact of bottle feeding to breastfeeding and milk supply

INDICATIONS

- Breastfeeding is the preferred feeding method for babies except if:
  - reasons parents are unable to breastfeed or breast milk feed e.g. medical condition (guidance provided by neonatal multi-disciplinary team)
  - parental choice to bottle feed (following informed conversations around feeding intention)

CONTRAINDICATIONS

- Parental choice to exclusively breastfeed
- Signs from baby which may suggest reduced airway protection resulting in aspiration
- Advisory – medical conditions which may impact feeding and swallowing e.g.
  - extreme prematurity
  - respiratory difficulties
  - gastro-intestinal difficulties
  - neurological impairment, structural difficulties e.g.
    - cleft palate
    - syndromes and chromosomal abnormalities
- Seek support from speech and language therapy

PROCEDURE

Action	Reason
• Support cue based and responsive approach to bottle feeding • See **Progression to suck feeding in preterm babies** guideline and the **Feeding Journey leaflet** (https://www.teamwmcn.nhs.uk/neonatal-guidelines)	• Feeding is a gradual developmental process in response to baby's cues and abilities • Transitioning from tube feeding to cue based and responsive bottle feeding enables baby time to develop and establish their feeding skills, and supports nutrition and growth • Support modified responsive feeding before moving to full responsive feeding
• Parents present and supported to be involved in baby's first bottle feed • Parents/carers to be supported to give most bottle feeds to their baby as primary care givers	• Supports parental partnership • Acknowledges importance of 'firsts' for families • Consistency • Attachment • Communication and interaction • Responsive feeding relationship
• Plan care activities around feeding opportunities based on baby's cues	• Supports parental partnership • Acknowledges impact of care on baby to maintain energy and appropriate state for bottle feeds

BOTTLE FEEDING IN THE NEONATAL UNIT ● 2/2

• Developmentally supportive environment, e.g. quiet environment, appropriate lighting, paced transfer from cot to parent	• Supports baby to move to a quiet and alert state for feeding
• Observe for baby's early feeding cues (opening eyes, stirring, stretching, rooting, bringing hands to mouth) • Baby should also: ◦ have stable heart rate, respiratory rate (not >60–65 breaths/min), adequate oxygen saturations, colour and skin tone appropriate for ethnicity ◦ be beginning to maintain a quiet, alert state for longer periods at feed times ◦ be able to bring hands to middle or to mouth, or beginning to maintain flexed posture ◦ be able to initiate and sustain rhythmic non-nutritive sucking on a finger or dummy ◦ be tolerating tube feeds	• Supports a positive feeding experience • Supports baby's co-ordination of sucking, swallowing, and breathing when bottle feeding
• Slow-flow teat (preferably parents/carers own choice) • Baby invited to take teat ◦ teat brushed downwards over midline of lips or placed still on bottom lip ◦ baby opens mouth and accepts teat	• Supports positive experience for bottle feeds • Helps milk to move more slowly – will help baby to have more time and control to support sucking, swallowing and breathing when bottle feeding
• Supported elevated side-lying feeding position (https://www.teamwmcn.nhs.uk/neonatal-guidelines)	◦ Comfortable ◦ Conserves energy • Supports midline position • Supports pacing of sucking, swallowing, and breathing when bottle feeding • If milk flow too fast, milk can escape at side of baby's mouth onto pillow
• Pacing: ◦ respond to baby's cues for signs that they may need support to pause to breath during bottle feeding ◦ pacing offered by lowering or removing teat	• Enables baby to be an active participant in bottle feed • Supports co-ordination of sucking, swallowing, and breathing when bottle feeding • Supports cue based and responsive feeding relationship
• Observe baby's bottle feeds in collaboration with parents and use bottle feeding assessment chart as a guide (https://www.teamwmcn.nhs.uk/neonatal-guidelines)	• Follow and respond to baby's early feeding cues • Use supportive strategies, e.g. elevated side-lying feeding position, slow flow teat and pacing • Follow and respond to baby's pause and stop cues during bottle feeds • Use tube feed top ups to support baby to develop and establish their feeding skills in response to their developmental abilities • Score using bottle feeding assessment chart https://www.teamwmcn.nhs.uk/neonatal-guidelines to guide understanding of baby's feeding development
• Practice with parents how to make up baby formula feeds following World Health Organisation and Department of Health and Social Care guidelines	• Supports prevention of infection and illness

BREAST MILK EXPRESSION ● 1/2

RATIONALE

- Breast milk feeding, even partial, reduces risk of necrotising enterocolitis (NEC), retinopathy of prematurity (ROP) and sudden infant death (SIDS) and improves cognitive outcomes in preterm babies
- Human milk is important in establishing enteral nutrition
- Any amount of mother's breast milk is valuable

GENERAL

- Early initiation of breast milk expression/feeding (within 2 hr of birth) is associated with adequate milk supply at 2 weeks
- Recognise that building a milk supply is a challenge for mothers who are separated from their babies and they will require consistent face-to-face support
- All mothers should have access to an electric hospital grade breast pump with the following characteristics:
  - easy to assemble and disassemble with all parts able to withstand sterilisation methods
  - fully automatic, with a cyclic suction rhythm that mimics baby suckling
  - vacuum strength ≤250 mmHg, and easily regulated
  - separate drive and suction system to ensure no contamination from milk spillage can enter pump
  - collection system enabling milk to be pumped directly into storage container with universal thread, to avoid need to transfer milk to another container for storage or administration
- Advise mothers to:
  - bath or shower daily
  - wash hands thoroughly with soap and running water before expressing
  - gently massage breast and stimulate nipple to trigger milk ejection reflex before milk expression
  - have regular prolonged skin-to-skin contact with their baby
  - stimulate oxytocin release by expressing next to baby where possible
  - complete expressing log and seek help if concerned about milk supply

MILK COLLECTION

- Use hand expression to express colostrum and collect milk obtained via a syringe (see **Nutrition and enteral feeding** guideline for advice on colostrum collection and administration)
- Commence hand expression as soon as possible following delivery (preferably within 2 hr)
- Frequency of expression: 8–10 times/24 hr (not leaving a gap >6 hr overnight)
- Teach all mothers hand expression
- Sterilise breast milk pump collecting kit before use
- If desired, combine hand expressing with pump expressing soon after birth
  - continue to hand express after using pump to help release higher fat milk and maximise supply
- Encourage simultaneous (double) pumping of both breasts. Tubular support bandage or an inexpensive bra with small holes made for funnels can be used to hold both kits in place
- Ensure mother has a properly fitting breast shield (funnel); nipple should fit comfortably in shield
  - may require different shield sizes as lactation progresses and to prevent nipple trauma caused by ill-fitting shield

TECHNIQUE

- Ensure mother seated in a comfortable chair and keep clothing away from breast while expressing milk
- Gentle massage of both breasts, working from the outside towards the nipple covering the whole breast
- Position breast pump shield (funnel) centrally over nipple with gentle pressure to obtain seal
  - if nipple rubs on walls of shield, it is too small
  - if breast tissue drawn into shield, it is too large
    - measuring tools available from some manufacturers
- Adjust suction control to increase vacuum slowly until slightly uncomfortable (not painful), then reduce until comfortable
- Use gentle pressure to obtain patent seal between breast and shield. Firm pressure will inhibit milk flow by compressing ducts
- Use gentle breast compression during expressing to increase efficacy of electric pump
- Express breasts as thoroughly as possible since fat content increases as breast is drained. Express until milk stops flowing
- If using a single pump, switch to second breast when milk stops flowing
- Use a new bottle for each expression
- Leave a space of 1–2 cm at the top of each bottle to allow for expansion during freezing

- After expression, wash equipment in hot soapy water with a bottle brush and rinse under cold running water, dry thoroughly with paper towels. Sterilise before next use
- Encourage mothers to practice 'kangaroo care' also known as skin-to-skin holding (see **Kangaroo care** guideline)
- Encourage mothers to express where they feel most comfortable; either close to baby or with baby picture/memento
- Complete expressing assessments at least once within the first 12 hr following delivery and ≥4 formal expressing assessments in the first 2 weeks (optimise milk production and address any issues related to expressing) See www.unicef.org.uk/babyfriendly/assessment-of-breastmilk-expression-checklist

Problems related to milk expression

Sore nipples

- Centre milk expression shield
- Try a variety of shield sizes
- Check pump vacuum and expressing technique
- Stop pump before removing shields
- Do not use plastic-backed breast pads
- Change breast pads frequently
- Consider infection

Improving milk supply

- **Complete BFI or unit expressing assessment**
- Increase kangaroo care (skin-to-skin)
- Express close to baby
- Check frequency of pumping, ensure including night-time expression
- Hand express after using the breast pump
- Check shield (funnel) size
- Encourage breast compression during expression
- Increase frequency of expression sessions
- Consider cluster expressing – mother expresses 2 or 3 times in a 4 hr period for 3–4 consecutive days
- Refer to infant feeding team for support
- Consider enhancing prolactin secretion using domperidone
- Praise provision of expressed milk, no matter how small

PARENT AND STAFF INFORMATION

- See www.unicef.org.uk/babyfriendly or www.bestbeginnings.org.uk/watch-small-wonders-online

BREAST MILK HANDLING AND STORAGE • 1/2

Improperly collected or stored breast milk can become contaminated and cause sepsis. Staff must adhere to local policies on collection of human milk and hand washing

PRECAUTIONS

- Wash hands thoroughly
- Cover cuts and abrasions and wear gloves when handling breast milk

Confirmed/suspected maternal infections

- Wash hands thoroughly before and after each pump session
- Ensure mother has a dedicated expressing pump, and disinfect after each use
- Use aseptic milk transfer technique to safely transfer milk to new storage container

ADMINISTRATION

- Ensure there is a dedicated breast milk fridge and freezer for storage on ward and this is accessed according to local policy
- Add date and time to bottle label when bottles placed into, and removed from, freezer/when additives added
- Ensure two persons check before administration to baby and/or addition of additives

ADVICE TO MOTHERS

- See **Breast milk expression** guideline
- Advise mothers to bath/shower daily
- Do not wash breasts with bactericidal detergent or soap
- Before expressing milk, it is essential to wash hands thoroughly with soap and water and dry with a disposable towel
- Wipe breast pump with disinfectant wipe before use
- Emphasise to mothers the importance of washing all breast milk collecting equipment properly before sterilising
- Wash equipment with hot, soapy water using bottle brush (not shared), rinse well and dry thoroughly with paper towels promptly after use. Sterilise before use. Discard bottle brushes on discharge
- Give all breastfeeding mothers information available from www.unicef.org.uk/babyfriendly and www.bestbeginnings.org.uk/watch-small-wonders-online

COLLECTION OF BREAST MILK

- Give mother collection kit (sterilise before use) and sterile bottles
- Provide parents with identification stickers to label milk (which include patient). Before giving a mother the patient identification stickers, positive identification must be made at the cot side/bedside by two people – can be between staff/parent
- Clearly label milk from individual mothers, adding baby's name, hospital number, date of birth and date and time expressed to the label
- Store in individual patient labelled containers in a dedicated breast milk fridge (individual containers must not hold bottles from >1 mother)
- Be aware blood and other pigments can discolour milk causing appearance to vary considerably

STORAGE

Where

- Store in designated fridge at 2–4°C. Freshly expressed breast milk can be stored for 48 hr before freezing
- Breast milk can be stored for 3 months at -20°C in designated freezer without a defrost cycle (in hospital)
- Freeze breast milk in small volumes with early expression so less milk requires defrosting and potentially less waste when establishing feeds
- Add date and time milk transferred to freezer to label
- Monitor fridge and freezer temperature twice daily using an indwelling maximum/minimum thermometer that is calibrated every 6 months. This temperature should be recorded – date/time, temperature and signature

How

- Place milk in an **upright** bottle/sterile container with airtight lid

BREAST MILK HANDLING AND STORAGE ● 2/2

- Ensure bottles labelled appropriately
- Store labelled bottles in individually labelled tray in designated breast milk fridge/freezer (individual containers must not hold bottles from >1 mother)
- Wash trays stored in fridge daily in warm soapy water, rinse well and dry thoroughly
- Clean trays between each use
- Gently agitate (**do not shake**) milk container to mix milk, then warm before use as refrigerated milk separates with fat globules forming top layer

DEFROSTING

- Use frozen milk in sequence of storage until enteral feeds established
- Thaw frozen milk in waterless warmer or in fridge (if warmer not available)
- Add date and time bottles removed from freezer/opened to bottle label
- If frozen milk needs to be thawed quickly (and warmer not available), hold bottle under cold or tepid water. Gently agitate and do not allow water to enter bottle via cap
- Discard any unused thawed milk (stored in fridge at 2−4°C) after 24 hr if defrosted in fridge or 12 hr if accelerated defrost

USE

- Once removed from fridge, fresh or defrosted milk must be used within 2−4 hr (2 hr preferable)
- Fresh milk is preferable to thawed milk
- Change continuous tube feeding (tubing between nasogastric tube and pump) every 4 hr
- To minimise fat loss, if using an enteral syringe driver position syringe delivering feed in semi-upright position
- Bolus feeds – warm milk before giving using waterless warmer if available (to minimise fat loss)
- Additives to be added to breast milk as close to feed time as possible
- Only warm volume of milk required for feed. Store remainder in designated fridge
- Before giving breast milk, conduct a 2-person check of the label and cross-reference with baby's identity bracelet to ensure milk is not given to wrong baby

TRANSPORTATION OF MILK

Milk is often transported from:

- Mother's home to hospital:
  - if mother expressing milk at home, provide supply of labels (instruct to add date and time expressed to each bottle)
  - transport in insulated container that can be easily cleaned
  - encourage mother to use coolant block to maintain stable temperature
- On arrival at hospital, store in fridge/freezer at earliest opportunity, ensuring any frozen milk has not defrosted en-route
- Hospital-to-hospital:
  - use rigid container for easy cleaning (e.g. cool box) and fill empty space with bubble wrap
  - use coolant block to maintain temperature. Transfer to fridge/freezer if frozen as soon as possible on arrival in NNU/ward
  - document amount of milk both fresh and frozen, to ensure any milk defrosted in transit is not refrozen on arrival

STORAGE FOLLOWING DISCHARGE

- Ensure parents take home all MEBM in the fridge or freezer. If some MEBM is left on unit and is in date, transfer from fridge to freezer immediately – inform parents to collect as soon as possible
- Give parents all MEBM on discharge and ensure all milk is checked for correct baby details:
  - crosscheck labels on bottles with patient ID (second checker ideally mother)
  - if parents are not present conduct two nurse check and document in patient notes
- Discard milk stored in NNU freezer 1 month after discharge or as per local policy
- Discuss with parents the opportunity of donating any unwanted MEBM to local donor milk bank

PRETERM BABIES

Rationale

- Breast milk feeding, even partial, reduces risk of necrotising enterocolitis (NEC), retinopathy of prematurity (ROP), sudden infant death (SIDS) and improves cognitive outcomes
- Human milk is important in establishing enteral nutrition
- Any amount of mother's fresh breast milk is better than none
- Physician advocacy has a strong influence on intention to feed

Buccal colostrum

- Counsel all mothers anticipating delivery of sick/preterm baby about benefits of colostrum and show West Midlands Neonatal Operational Delivery Network video, **Early expressing and benefits of colostrum** available at https://www.wmnodn.org.uk/media/
- Advise mothers to hand express as soon after delivery as possible (ideally within 2 hr of birth)
- Initiate administration of buccal colostrum as soon as colostrum available (ideally within 6 hr of birth and always within 24 hr)

Parent and staff information

- See www.unicef.org.uk/babyfriendly or http://www.bestbeginnings.org.uk/watch-small-wonders-online

IMPLEMENTATION

- In pregnancy at high risk of premature delivery, discuss feeding preferences, advantages of breastfeeding and how expression of breast milk can be supported
- If delivery is imminent (any gestational age) or high risk pregnancies >36 weeks, consider antenatal colostrum collection
- Discuss value/benefits at birth and during mother's first visit to NNU
- Document discussion in maternal and babies' healthcare records
- Encourage mothers to practice 'kangaroo care' also known as skin-to-skin holding (see **Kangaroo care** guideline)
- Separate the decision to provide a few weeks' pumped breast milk from the commitment to long-term, exclusive breastfeeding
- Praise all efforts to provide breast milk
- Ensure adequate discussion and provision of written information on hand expression, and on mode and frequency of pump use (see **Breast milk expression** guideline)
- See **Progression to suck feeding in preterm babies** guideline regarding establishing breastfeeding and responsive feeding

CONTRAINDICATIONS TO BREASTFEEDING

Babies with galactosaemia should not receive breast milk

HIV in UK

- Always check maternal HIV status before breastfeeding
- breastfeeding contraindicated in UK
- if you are concerned that mother intends to breastfeed, ensure an HIV specialist explains risk to baby, allowing the mother to make an informed decision
- if decision made by mother to breastfeed after advice, signpost to breastfeeding support

HIV in developing countries

- If returning to a developing country where there is no access to clean water, exclusive breastfeeding is safer than mixed

Maternal medications

The risk of the medication to baby is dependent on gestation, age and clinical condition of baby

- Antimetabolites or cytotoxic drugs
- Radioisotope investigation (until isotope clears)
- See **Neonatal Formulary, BNF, 'Medications and mother's milk' by T W Hale,** https://www.ncbi.nlm.nih.gov/books/NBK501922/?report=classic or https://www.sps.nhs.uk/home/guidance/safety-in-breastfeeding/

A current, reliable reference for drugs and breastfeeding must be available on NNU

BREASTFEEDING WITH SPECIAL PRECAUTIONS

Tuberculosis (TB)

- Maternal sputum-positive TB is not a contraindication to breastfeeding
- If mother on isoniazid, give prophylactic pyridoxine to mother and baby
- Refer to **Tuberculosis (investigation and management following exposure in pregnancy)** guideline for further advice

Cytomegalovirus (CMV)

- Mothers who have a primary CMV infection or reactivation may be infective. Take senior microbiological advice on testing and feeding

Hepatitis B

- Risk of transmission can be almost totally eliminated by a combination of active and passive immunisation
- Breastfeeding not contraindicated
- See **Hepatitis B and C** guideline

Hepatitis C

- Transmission by breastfeeding theoretically possible but has not been documented
- Breastfeeding not contraindicated but inform mother risks unknown – consider avoiding breastfeeding if nipples cracked, as increased risk of infection

Varicella-zoster virus (VZV)

- Babies of mothers with active VZV can reduce risk by avoiding breastfeeding until mother is no longer infectious (5 days from onset of rash)
- Premature babies born <1 kg or <28 weeks are considered high risk and should be given varicella-zoster immunoglobulin (VZIG) (see **Varicella** guideline)

Herpes simplex type 1

- Omit breastfeeding or feeding expressed breast milk (EBM) from affected side in women with herpetic lesions on breast until lesions have healed
- cover active lesions elsewhere
- careful hand hygiene essential
- affected side: cover, pump and discard milk (no breastfeeding) until lesions are clear
- unaffected side: can breastfeed and use EBM

Phenylketonuria (PKU)

- Breastfeeding not contraindicated in babies with PKU
- Screening service will contact paediatric dietitians directly
- Careful dietetic management necessary
- All babies to be under the care of paediatric dietitians and inherited metabolic diseases team

Radioactive diagnostic agents

- Women receiving radioactive diagnostic agents to pump and discard, although most agents have very short plasma half-lives. Seek advice from hospital nuclear medicine department as to how long to discard milk for

Medications

- For medications that require caution with breastfeeding, see **Maternal medications**

Social drugs

Alcohol

- Discourage more than limited consumption

Nicotine

- Nicotine concentration in breast milk increases immediately after smoking
- Discourage mothers from smoking directly before breastfeeding or expressing breast milk

BROVIAC LINE INSERTION ● 1/3

INDICATIONS

- Long-term central venous access necessary (over 3–4 weeks) and all peripheral sites for central catheters (PICC) have been exhausted
- Referring neonatologist must balance risks of procedure/transfer against benefits
- All permanent cuffed central lines (Broviac lines) are inserted at Birmingham Children's Hospital (BCH) by a consultant member of the vascular access team

CONTRAINDICATIONS

- Pyrexial or septic baby. Remove any other lines e.g. PICC and administer antibiotics until apyrexial for ≥48 hr before insertion of Broviac line

CONSENT AND COMMUNICATION WITH PARENTS

- Before transferring to surgical centre, explain procedure to parents and discuss risks including:
  - infection
  - bleeding/bruising
  - damage to heart, pneumothorax, haemothorax (extremely rare)
  - damage to lungs, cardiac tamponade or arrhythmias (very rare)
  - line block (thrombus, fibrin sheath, or dislodgement)
  - break (either externally or internally)
  - fallout
  - wound problems
- Inform parents a surgical team member will meet with them before the procedure to discuss their concerns and complete a formal consent form
  - if parents unable to attend surgical centre on day of procedure, formal 'delegated consent' must be gained by local neonatal team and completed consent form must accompany baby to surgical centre. File a copy in baby's healthcare record. This should be discussed with the surgical team
- Document all discussions with parents in baby's healthcare record

COMPLICATIONS

- On insertion:
  - pneumothorax
  - haemothorax
  - bleeding/haematoma
  - cardiac tamponade
  - malposition
  - extravasation
  - venous occlusion
- In established lines:
  - infection
    - line
    - skin
    - cuff
    - endocarditis
  - breakage
  - blockage
  - displacement
  - thrombus on tip
  - venous occlusion
- Causes of line blockage and difficulty with aspiration and flushing:
  - tip of line in wrong place
  - lumen blocked
    - blood clot
    - PN/drug concretion
  - fibrin sheath over end of line
  - thrombus at tip of line
    - blood clot or vegetations
  - line tip pressed against
    - vessel wall
    - heart valve
    - atrial wall

- line partially pulled out, tip no longer in vessel
- tip eroded through lumen and lying outside vessel
- damage to line or lumen

INSERTION

- Inserted using an ultrasound guided percutaneous approach under general anaesthetic at a paediatric surgical centre
- BCH consultant from vascular access team will insert the line
- preferred line tip position, high right atrium
  - check position with contrast under fluoroscopy guidance
- Blood transfusions due to bleeding as a complication of surgery are very rarely required and usually occur due to an underlying condition

Referral

- Refer to the lines service at planned place of surgery. Arrangements will be made on an individual basis depending on degree of urgency and clinical need
- Once procedure date set, liaise with transport team
- Ensure transfer letter is ready to accompany baby, together with recent FBC, clotting screen and U&E
- Prepare baby for transfer. Follow pre-operative fasting instructions from surgical team

Post-operative care

- Lines will be imaged in theatre
- Line will be looped on the chest under an IV3000 dressing +/- a biopatch
- biopatch used for babies >26 weeks and aged >7 days
- avoid excessive pressure over the patch (risk of skin necrosis)
- Change dressing weekly for 3 weeks
- 2.7 Fr line – sodium chloride 0.9% at ≥1 mL/hr continuous infusion to prevent blockage
- 4.2 Fr line – when not in use:
- heplock twice weekly with heparin 0.4 mL (10 units/mL)
- use aseptic technique
- Clamp catheter immediately following instillation of heparin
- To use a heplocked line, aspirate the lumen until blood is first withdrawn and discard the aspirated solution

REMOVAL

- Neonatal consultant will decide when line to be removed, often following discussion with surgeons

Indications

- Line no longer needed
- Line blocked or damaged
- Cuff dislodged so that it is visible outside the skin
- Central line infection, not controlled by antibiotics
- Evidence of sepsis with no obvious cause, not controlled by antibiotics
- Repeated (>2) episodes of Broviac line related sepsis

Preparation for removal

- Discuss with surgical team or surgical outreach nurse
- Discuss procedure, benefits and risks with parents and document discussion in baby's healthcare record
- Most Broviac line removals are performed at the neonatal surgical centre on an elective basis according to the degree of urgency and other clinical needs (occasionally consultant surgeon may perform the procedure on NNU)
- Once date agreed, inform transport team
- Ensure transfer letter is ready to accompany baby, together with results of recent FBC, clotting screen and U&E
- Prepare baby for transfer. Follow pre-operative fasting instructions from the surgical team

Equipment required if surgeon removing line on NNU

- Surgical consent form
- Trolley
- Sterile dressings pack
- Cut-down pack (e.g. insertion of UVC or chest drain)

- Local anaesthetic (e.g. lidocaine 1%)
- Sterile pot to send tip to microbiology
- Sterile gauze
- Cleaning fluid i.e. chlorhexidine etc.
- Steri-Strips™
- Mepore® dressing

Potential complications of line removal

- Bleeding – usually oozes from exit site that will settle with pressure
- pressure may need to be applied to neck, just above clavicle (venous puncture site)
- Infection
- Line breaking during removal (embolisation) – very rare but line tip may require removal
- Wound problems

Embolised fractured line

- If line stops working and simple techniques do not manage to unblock it, perform chest X-ray to rule out fracture
- Very rare but occasionally line will break causing the tip to embolise into the right atrium or pulmonary artery. This is not a reason to panic or alarm the parents as removal is relatively straightforward
- Requires retrieval by interventional cardiologist at paediatric surgical centre. Liaise with either on-call paediatric surgeon, cardiologist, or vascular access team (line service) at planned place of surgery

USEFUL INFORMATION

- http://www.e-lfh.org.uk/programmes/paediatric-surgery/

CANNULATION – PERIPHERAL VENOUS ● 1/1

INDICATIONS
- Access for IV infusion and medications

CONTRAINDICATIONS
- Sore or broken skin

EQUIPMENT
- Cleaning solution (see local Trust policy)
- Sucrose 24% solution
- Appropriate blood bottles and request cards
- Non-sterile disposable gloves
- 24 G cannula
- T-piece connected to a syringe of sodium chloride 0.9%, flushed and ready
- Tape and splint to secure cannula
- 3-way tap if necessary

PROCEDURE
Preparation
- Local anaesthetic cream not used in neonates. See **Pain assessment and management** guideline for advice on alternatives
- Identify suitable site
  - preferably back of hand or foot
  - save long saphenous and antecubital fossa veins for long line insertion
  - scalp: shave area if using scalp vein (do not use as first priority site)
- Inform parents before procedure if possible
- Identify suitable vein, which should be clearly visible. Unlike in adults, neonatal veins are rarely palpable

If baby likely to need numerous cannulations, avoid using potential long line veins

- It can be helpful to flush cannula with sodium chloride 0.9% to assist in identification of point at which cannula enters vein. If blood samples taken at time of cannula insertion, **do not** flush cannula as this will contaminate sample for analysis
- Wash hands and put on gloves

Insertion
- Apply hand pressure around limb to distend vein
- Place thumb on skin slightly distal to proposed puncture site
- Hold cannula at 10–20° angle and puncture skin
- Advance cannula toward vein
  - resistance may diminish slightly as it enters vein and a speck of blood may be seen in hub of needle (this is easier to see if cannula has been flushed with sodium chloride 0.9%). **Do not** advance needle further as it can pierce back wall of vein
- When this occurs, hold needle steady and advance cannula a short distance within vein
- Withdraw needle from cannula
- Connect T-piece and flush cannula gently with sodium chloride 0.9% 0.5 mL to confirm it is in the vein
- Secure cannula with clear dressing (e.g. Tegaderm™/Opsite) to ensure IV site visible at all times, and connect to infusion
- Little evidence that use of a splint prolongs the life of a cannula

Documentation
- Record date, time and site of cannula insertion in notes with identification and signature of person carrying out procedure (use local sticker if available)
- Record date, time and reason for removal of cannula
- Use visual phlebitis scoring for ongoing monitoring of cannula, according to local Trust policy

CARDIAC MURMURS • 1/1

Failed oximetry:
See **Pulse-oximetry (universal) screening** guideline
- Lower limb SpO_2 <95%
- Pre and postductal difference of >2%

Cardiac murmur detected on routine postnatal examination

- Thorough cardiovascular examination
- Pre and postductal saturations
- **Senior paediatric review**

Any of the following
- Failed oximetry (see box above)
- Weak or absent femoral pulses
- Signs of heart failure
- Cardiovascular shock

Significant congenital heart disease

URGENT
- Admit to NNU
- +/- ECG, chest X-ray, 4-limb BP and blood gas analysis
- Hyperoxia test +/- prostin (see **Congenital heart disease: duct dependent lesions** and **Prostaglandin infusion** guidelines)
- Echo (performed locally, if available)
- Liaise with regional cardiologist

Any of the following
- Pansystolic/diastolic/continuous
- Loud murmur (≥3/6 intensity)
- Murmur plus dysmorphic features

Possible congenital heart disease

SOON
- Senior review
- ECG +/- echo before discharge if available
- **Review by consultant paediatrician** (+/- echo skills) within 2–4 weeks
- Advise parents to watch for signs of heart failure
- Inform GP

All of the following
- Asymptomatic well baby
- No signs of heart failure
- Normal pulses
- Normal saturations
- Soft systolic murmur (≤2/6)

Likely innocent heart murmur

ROUTINE
- Baby to remain in hospital
- Review aged ≥24 hr
- Recheck saturation level
- Echo before discharge if available or
- Review in paediatrician outpatient clinic within 4–6 weeks
- Advise parents to watch for signs of heart failure
- Inform GP

Grades of cardiac murmur
Grade 1 – barely audible
Grade 2 – soft but easily audible
Grade 3 – moderately loud, no thrill
Grade 4 – loud with thrill
Grade 5 – audible with stethoscope barely on chest
Grade 6 – audible with stethoscope off chest

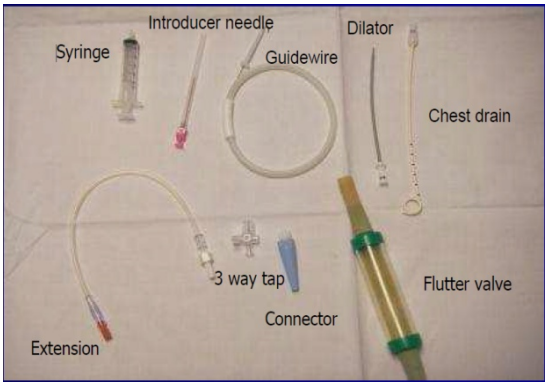
Signs and symptoms of heart failure:
- Lethargy, not waking up for feeds
- Poor feeding
- Fast or abnormal breathing
- Chest recessions
- Sweaty during feeds
- Colour changes
- Poor weight gain

CHEST DRAIN INSERTION – SELDINGER TECHNIQUE ● 1/3

INDICATIONS

- Treatment of pneumothorax or pleural effusion

EQUIPMENT



- Introducer needle
- Chest drain
- Guidewire
- Dilator
- 3-way tap
- Extension
- Connector
- Flutter valve or underwater seal
- Steri-Strip™
- Transparent dressing

PROCEDURE

- It is advisable that 2 people are scrubbed for this procedure

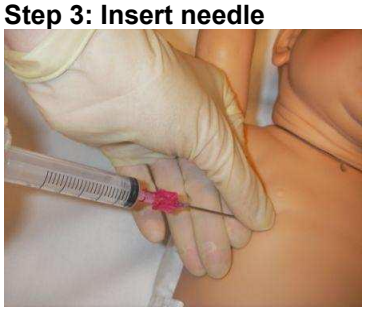
Step 1: Analgesia

- Ensure baby has adequate analgesia
  - if ventilated: use morphine bolus
  - if non-ventilated: use low-dose fentanyl (watch for chest wall rigidity)
  - lidocaine locally

Step 2: Aseptic technique

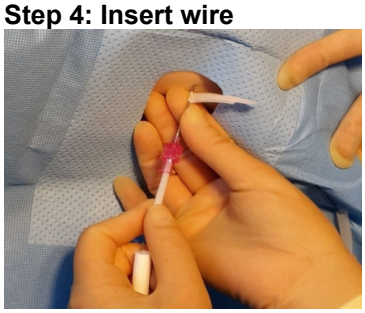
- Use sterile gloves and gown
- Identify site
- Clean skin according to local policy

Step 3: Insert needle



- Select location for chest drain – usually 5th intercostal space, anterior axillary line
- Place Steri-Strip™ 1 cm from bevelled end of needle
  - ensures needle not advanced too far
  - acts as marker in case of needle slipping out
- Insert needle whilst aspirating syringe
- Stop advancing once air aspirated (<1 cm)

Step 4: Insert wire



- Pass wire through needle ensuring wire is not inserted any further than silver mark. Holding wire still, remove needle

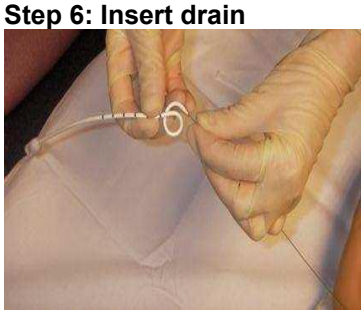
Take care to keep equipment sterile at all times. This may require an assistant to 'control' wire

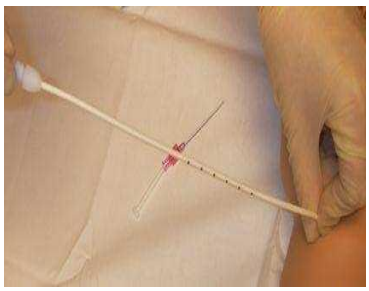
Step 5: Dilate the skin

- Pass dilator along wire
- Push dilator through skin approximately 1 cm, angling anteriorly
- Skin may require small incision
- Following dilation, dilator can be removed

At all times wire must be held still, not advanced or withdrawn

Step 6: Insert drain

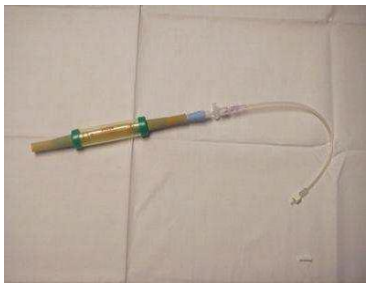




- Advance drain over wire (this often needs an assistant)
- Advance drain through skin so holes are inside baby's pleural space – i.e. at least 1 cm from the skin and insert to:
  - preterm babies: 1st–2nd black mark
  - term babies: 3rd–4th black mark
- Wire can now be removed

Step 7: Add flutter valve or connect to underwater seal

- Assemble drainage equipment
- extension
- 3-way tap
- connector and flutter valve or underwater seal and suction
- if connected to underwater seal use 5–8 cm H_2O pressure suction



- Attach valve/underwater drain with suction to end of drain
- Chest X-ray to confirm position and monitor progress/resolution of pneumothorax or pleural effusion

Step 8: Secure drain

- Carefully secure drain
- **do not** use a purse string suture
- secure chest drain with Steri-Strip™ and Tegaderm™
- if required, suture may be placed through skin and knotted to drain

HOW TO REMOVE

- Wear personal protective equipment, i.e. gloves, eye protection
- Remove sutures and Tegaderm™
- Gently pull drain – pigtail will uncurl
- Beware of splashing body fluids – as drain comes out of skin, pigtail catheter will spring back

CHEST DRAIN INSERTION – TRADITIONAL ● 1/2

INDICATIONS

- Treatment of pneumothorax or pleural effusion

EQUIPMENT

- Sterile dressing pack
- Cleaning solution as per unit policy and wash off with sodium chloride 0.9% once dried for babies <26 weeks' gestation
- Lidocaine 1%, with syringe and needle for preparation and injection
- Chest drains size FG 8,10,12 (use largest possible depending on size of baby)
- Low pressure suction unit
- Scalpel and fine straight blade (size 11)
- Fine blunt forceps
- Underwater seal chest drainage bottle and tubing or flutter (Heimlich) valve
- Steri-Strip™ and transparent dressing (e.g. Opsite/Tegaderm™)

SITES

- Site of insertion depends on position of pneumothorax
- preferred site is in anterior axillary line, between 4th and 6th intercostal space, to conceal subsequent scarring and avoid interference with breast development
- alternative site is just lateral to midclavicular line, in 2nd or 3rd intercostal space
- if pneumothorax does not drain satisfactorily, it may be necessary to insert >1 drain
- for pleural effusion, use midaxillary line between 4th and 5th intercostal spaces, and direct drain posteriorly

PROCEDURE

Preparation and position of baby

- Inform parents and obtain consent as recommended by BAPM (unless emergency procedure)
- Use 10–12 FG pleural catheter (small babies may need 8 FG)
- Position baby supine and flat with affected side slightly tilted up (e.g. by using a folded blanket)
- Prepare skin with full aseptic technique
- Infiltrate with lidocaine 1%, **even in babies being given systemic analgesia**

Insertion of tube

- Make small incision in skin with scalpel at lower edge of intercostal space to avoid injury to intercostal vessels
- Dissect bluntly with fine forceps through intercostal muscle and pleura
- Use fine forceps to gently advance tip of catheter
- Push and twist tube gently through incision into pleural space
- Insert chest drain 2–3 cm for small preterm and 3 cm for term babies
- If drain has additional proximal hole, ensure this lies within chest cavity
- Use of trocar not generally recommended. If used (in bigger baby), protect lung by clamping artery forceps onto trocar 1 cm from the tip
- Connect tube to prepared underwater seal or flutter (Heimlich) valve
- Manipulate tube gently so that tip lies anteriorly in thoracic cavity for pneumothorax, and posteriorly for effusion
- Secure tube with Steri-Strip™, and cover with gauze dressing. A suture may be required; **do not use purse-string suture**
- Secure tube to chest wall using suitable tape (Opsite/Tegaderm™)

AFTERCARE

- Check bubbling or oscillation of water column seen with every inspiration
- Check tube position with chest X-ray (consider lateral X-ray to confirm position)

Suction

- If bubbling is poor/absent and X-ray confirms drain is in correct position but pneumothorax not fully draining on X-ray or cold light, apply continuous suction of 5–10 cm H_2O. Thoracic suction is better suited for this purpose than routine wall suction. Occasionally, a second drain may be necessary

Flutter valve

- Use as an alternative to underwater chest drain system, especially during transport

Document

- Record presence of bubbling (continuous/intermittent/none) on nursing care chart
- Record oscillation of water column or fluttering of valve seen with every inspiration on nursing care chart

REMOVAL OF CHEST DRAIN

- Remove when no bubbling or oscillation of water column has occurred for 24 hr
- Clamp chest drain for 12 hr and repeat chest X-ray before removal**.** While removing drain, ask an assistant to hold wound edges close together
- After removing drain, close wound with Steri-Strip™; a suture is seldom necessary
- Close clinical observation after removal of drain is sufficient to diagnose reaccumulation of the air leak, routine chest X-ray not generally warranted

CHRONIC LUNG DISEASE● 1/2

RECOGNITION AND ASSESSMENT

Definition

	Gestational age	
	<32 weeks	**≥32 weeks**
Time of assessment	36 weeks' CGA or discharge	>28 days, but <56 days postnatal age or discharge
Treatment with oxygen	**≥**28 days	**≥**28 days
	Bronchopulmonary dysplasia	
Mild	In air at 36 weeks' CGA or discharge	In air by 56 days postnatal age or discharge
Moderate	<30% oxygen at 36 weeks' CGA or discharge	<30% oxygen at 56 days postnatal age or discharge
Severe	≥30% oxygen +/- CPAP or ventilation at 36 weeks' CGA or discharge	≥30% oxygen +/- CPAP or ventilation at 56 days postnatal age or discharge

Target saturations 93–97% at 36 weeks' CGA (see **Oxygen saturation** guideline for details)

Investigations at time of assessment (see above)

- Blood gas
- Chest X-ray: homogeneous opacification of lung fields developing after first week after birth or coarse streaky opacities with cystic translucencies in lung fields can be suggestive of CLD
- Echocardiography to rule out pulmonary hypertension or structural pathology
- Electrocardiography to rule out pulmonary hypertension
- Overnight pulse oximetry study (see **Oxygen on discharge** guideline)

TREATMENT

Optimise ventilation strategies

- Volume-targeted/volume-guarantee ventilation is preferred mode of ventilation in neonates
- if using pressure limited ventilation, use lowest possible ventilator pressures to deliver appropriate tidal volumes to minimise volutrauma/barotrauma [see **Ventilation**: **volume-targeted (volume guarantee/targeted tidal volume)** and **Ventilation: synchronous positive pressure ventilation (SIPPV)** guidelines]

Optimise nutrition

- Ensure adequate nutrient intake (120% of normal) because of increased work of breathing
- If growth unsatisfactory, involve neonatal/paediatric dietitian (see **Nutrition and enteral feeding** guideline)
- Avoid fluid overload

Corticosteroids

- If ventilator-dependent and requiring increasing or persistently high oxygen intake, consider using corticosteroids
- treatment with corticosteroids (dexamethasone/hydrocortisone) is a consultant decision
- **do not** use dexamethasone with non-steroidal anti-inflammatory drugs
- Inform parents of potential short-term and long-term adverse effects and benefits
- Obtain oral consent and record in notes

Short-term side effects of corticosteroids

- Risk of infection
- Poor growth
- Reversible ventricular hypertrophy
- Gastrointestinal perforation and bleeding
- Adrenal suppression
- Glucose intolerance

Long-term side effects of corticosteroids

- Increased risk of neurodisability

Doses

- Use **Neonatal Formulary** for dexamethasone dosage regimen (consultant decision on DART versus Minidex® regimen)
- If respiratory status worsens after initial improvement repeat course may be needed (consultant decision)

Monitoring while on corticosteroids

- Daily BP and urinary glucose

Diuretics

- Use of diuretics to improve lung function (consultant decision). Diuretics of choice are chlorothiazide and spironolactone (use of spironolactone can be guided by serum potassium). Avoid amiloride due to its lung fluid retaining properties
- Side effects include hyponatraemia, hypo/hyperkalaemia, hypercalciuria (leading to nephrocalcinosis) and metabolic alkalosis
- If no improvement on diuretics, stop after 1 week

SUBSEQUENT MANAGEMENT

Monitoring treatment

Continuous

- Aim for SpO_2 91–95% until 36 weeks' CGA
- After 36 weeks' CGA, maintain SpO_2 93–97% to prevent pulmonary hypertension
- Warm and humidify supplemental oxygen unless on low-flow oxygen
- Monitor weight, length and head growth (see **Growth monitoring** guideline)
- Assess for gastro-oesophageal reflux [see **Gastro-oesophageal reflux disease (GORD)** guideline]
- Aim to stop diuretic therapy before discharge (consultant decision)

DISCHARGE AND FOLLOW-UP

- If still oxygen-dependent at time of discharge, see **Oxygen at discharge** guideline
- Long-term neurodevelopmental and respiratory follow-up

- Haemostasis is immature during the neonatal period and does not attain full function until aged 6 months
- Normal ranges for prolonged prothrombin time (PT) and activated partial thromboplastin time (APTT) are difficult to define, making interpretation of results difficult
- There is considerable uncertainty about the use of fresh frozen plasma (FFP) in neonates
- Prophylactic use of FFP, including before surgery, is of unproven benefit

INVESTIGATIONS

Do not perform coagulation screening routinely.
Results are difficult to interpret, and routine testing may lead to increased transfusion of FFP without benefit

Check clotting in:
- Selected babies with evidence of bleeding or who are at high risk of disseminated intravascular coagulation (DIC) e.g. severe sepsis or NEC
- Babies receiving therapeutic hypothermia
- Metabolic disease: urea cycle disorder, galactosaemia, tyrosinaemia, organic acidaemia
- Significant liver dysfunction or conjugated jaundice
- Babies undergoing surgery or tissue biopsy who have had previous bleeding problems
- Family history of inherited bleeding disorder (after discussion with consultant haematologist)
- Thrombocytopaenia (see **Thrombocytopaenia** guideline)

Sampling
- Ensure sample from a free-flowing vein (peripheral or umbilical) or from an arterial line before heparinising
- Fill exactly to black mark on tube (usually 1.3 mL)
- If sample clots (this does not confirm normal coagulation), repeat
- If sampling from arterial line with heparin infusion, take larger volume (e.g. 2.5 mL) from dead-space (see **Arterial line sampling** guideline)

Request
- INR (measure of PT)
- APTT
- Fibrinogen
- If features of DIC (e.g. bruising, bleeding, sepsis), request fibrin degradation products and D-dimer (if available)

If concerned/unsure about initial results, seek senior advice

Normal values

Test	Value	
	30–36 weeks' gestation	**Term**
Prothrombin time	8.5–17 sec	8.5–14.4. sec
Activated partial thromboplastin time	0–21 days: 27–75 sec 22–90 days: 26.9–62.5 sec	28–55 sec
Thrombin time	9–15 sec	9–15 sec
Fibrinogen	1.5–4.0 g/dL	1.5–4.0 g/dL

Note
- Normal values vary greatly between sources. Few sources give values for preterm babies
- Coagulopathy defined as PT or APPT >1.5 x midpoint of normal range

IMMEDIATE TREATMENT

- No evidence to support the use of FFP to try to correct abnormalities of coagulation screening alone in non-bleeding babies
- FFP may be of benefit to babies with clinically significant bleeding (including massive blood loss) or before invasive procedures with a risk of significant bleeding, if they also have an abnormal coagulation profile defined as a PT or APTT significantly above normal gestation or postnatal age-related reference range (see **Table**)
- In inherited clotting factor deficiencies, use FFP only when pathogen inactivated factor unavailable. Discuss with consultant haematologist before giving FFP

COAGULOPATHY ● 2/2

- If INR alone is raised (>2), and clotting samples were performed before first dose of vitamin K, repeat clotting screen. If sample taken after first dose of vitamin K, repeat dose (see **Vitamin K** guideline)
- vitamin K dose also indicated in case of isolated raised INR or prolonged PT
- If APTT raised and active bleeding give FFP 10–20mL/kg over 30-60 min

Do not use FFP or cryoprecipitate purely for volume replacement or polycythaemia without coagulopathy

Cryoprecipitate

- Indicated for hypofibrinogenaemia (fibrinogen level <0.8–1.0 g/L) either congenital or secondary to DIC/sepsis **WITH** bleeding
- Give 5–10 mL/kg over 30–60 min

MONITORING

- Repeat coagulation profile 2–4 hr after FFP/cryoprecipitate
- Give further treatment only if bleeding persists – do not treat abnormal clotting screen in the absence of bleeding
- If abnormal coagulation persists for >24 hr in the absence of any precipitating factors, seek advice from haematologist

CONGENITAL DIAPHRAGMATIC HERNIA● 1/4

INTRODUCTION

Congenital diaphragmatic hernia (CDH) is a congenital defect in the diaphragm (usually detected antenatally) resulting in herniation of abdominal contents into the thoracic cavity; associated with a high risk of mortality and morbidity. A combination of pulmonary hypoplasia and abnormal morphology of the pulmonary vasculature leads to severe respiratory insufficiency and increased risk of developing persistent pulmonary hypertension (PPHN)

RECOGNITION AND ASSESSMENT

Antenatal diagnosis

- Delivery to be planned at regional neonatal intensive care unit (NICU)
- Fetal medicine team and paediatric surgeon to provide antenatal counseling
- Neonatal team to meet parents before delivery
- Neonatal consultant, tier 2 staff and NICU nurse to attend delivery

Postnatal diagnosis

- In some babies the lesion develops later in gestation; these babies tend to have a better prognosis
- Postnatal presentation can be with clinical features ranging from inability to resuscitate baby at birth to incidental finding on chest X-ray

In cases diagnosed postnatally there may be early respiratory distress in association with a scaphoid abdomen and heart sounds shifted usually to the right. Mask inflation will often cause deterioration as air is delivered into herniated gut resulting in cardiorespiratory embarrassment

INVESTIGATIONS

- Pre and postductal SpO_2
- Chest and abdominal X-ray
- Arterial blood gas
- Echocardiogram

IMMEDIATE MANAGEMENT AT DELIVERY

Key principles

- Intubate all antenatally diagnosed babies promptly (intubation to be carried out by most experienced and reliable operator present)
- Optimise ETT position and size, aiming for little or no leak, with largest size tube feasible
  - confirm tube position by end tidal CO_2 monitoring
- Do not give mask ventilation – will introduce air into the GI tract and compromise ventilation
- Maintain low peak pressure <25 cm H_2O and positive end expiratory pressures of 5 cm H_2O to avoid lung damage
- Avoid high airway pressures
- Establish adequate perfusion and oxygenation
  - aim for preductal SpO_2 80–95% after first 10 min
  - avoid hyperoxia, reduce FiO_2 when preductal saturation >95%
- Insert large gauge 8–10 Fr NGT
  - aspirate at least every 5 min to decompress stomach until baby established on ventilation, then place on free drainage
- Check temperature before transfer to NNU, maintain normothermia
- Examine baby for other associated abnormalities e.g.:
  - cardiac (present in 20%)
  - trisomy 18/21
  - urogenital
  - musculoskeletal

MANAGEMENT ON NNU

Undertake management PROMPTLY
Babies with CDH fare better with minimal handling – handle baby as little and as gently as possible

- Weigh baby

- Start on conventional ventilation with low tidal volume strategy of 3–4 mL/kg
- Sedation: morphine 20 micrograms/kg/hr
- Umbilical venous and arterial catheters
  - to be sited by experienced operator (initial management is time critical)
  - if not possible to site umbilical arterial catheter (UAC), insert peripheral arterial line
- Monitor pre and postductal SpO_2
  - first 2 hr **only**: if pH >7.2, $PaCO_2$ <8.6 kPa and saturations improving, aim for preductal saturations of >70%
  - **after** first 2 hr: if lactate and pH acceptable (pH >7.2, lactate <5 mmol/L) on arterial blood gas, aim for preductal SpO_2 80–95% (UAC measures postductal PaO_2) and postductal SpO_2 >70%
  - an abnormal lactate is an indicator of poor perfusion and must be corrected before the interpretation of acceptable levels of SpO_2
- Maintain arterial blood pressure at normal level for gestational age
- Surfactant **NOT** routinely recommended. Only to be administered after discussion with regional centre as risk of over-distension and pneumothorax
- Cardiac echocardiogram (ideally within 6 hr of birth) to:
  - exclude associated congenital cardiac disease
  - assess right ventricular function
  - look for evidence of persistent pulmonary hypertension (see **Pulmonary hypertension** guideline)
  - identify patent ductus arteriosus and assess shunting (see **Patent ductus arteriosus** guideline)

Ventilation

Gentle conventional (see* Ventilation: conventional *guideline)

- Avoid peak pressures >25 cm H_2O, maintain PEEP 3–5 cm H_2O
  - if greater peak pressures required to maintain preductal SpO_2 >80% and postductal SpO_2 >70%, discuss HFOV with consultant
    - if HFOV not available discuss with specialist centre e.g. KIDS NTS/BWCH to expedite retrieval

HFOV [see* Ventilation: high frequency oscillatory (HFOV) *guideline]

- Initial setting:
  - MAP: 12 cm H_2O (do not increase >16 cm H_2O)
  - rate/frequency: 10 Hz, delta P 25
- Chest X-ray 1 hr after commencing HFOV
  - if >8 rib spaces visible, lungs are hyper-inflated – reduce MAP

Target O_2 saturations

- Aim for preductal SpO_2 of 80–95%
  - if MAP >12 cm H_2O and FiO_2 >0.6 to maintain preductal SpO_2 >80%, commence inhaled nitric oxide (iNO) at 20 ppm (see **Nitric oxide** guideline)

Permissive hypercapnia

- If pH >7.2, lactate <5 and urine output >1 mL/kg/hr: target $PaCO_2$ 6.9–9.3 kPa

Systemic blood pressure support

- Invasive blood pressure monitoring required
- If preductal SpO_2 80–95%, aim for mean arterial blood pressure corresponding to gestation
- Maintenance fluid volume: 60 mL/kg/day
- Treat hypotension or poor tissue perfusion (rising lactate, urine output <1 mL/kg/hr) with fluid boluses sodium chloride 0.9% 10 mL/kg (maximum 30 mL/kg)
- If heart rate normal, urine output >1 mL/kg/hr, lactate <3 – do not give inotropes
- If persistent hypotension or hypoperfusion and difficulty maintaining preductal saturation 80–95%, give inotropes

Term babies

- Start adrenaline 100–1000 nanogram/kg/min as first line (starting dose usually 300 nanogram/kg/min)
- If right ventricular failure on echocardiogram discuss adrenaline with specialist centre e.g. KIDS NTS
- If right ventricular failure add milrinone 35–45 microgram/kg/hr (starting dose 35 micogram/kg/hr; **DO NOT** give loading dose) and noradrenaline base 20–100 nanogram/kg/min (starting dose 20 nanogram/kg/min)

Preterm babies

- Start dopamine 10 microgram/kg/min and increase to 20 microgram/kg/min
- if excessive tachycardia (heart rate >200 bpm) secondary to dopamine, discuss with specialist centre e.g. KIDS NTS and add noradrenaline
- Monitor lactate – rise in lactic acidosis suggests excessive vasoconstriction by inotropes

Metabolic acidosis

- Accept pH >7.2
- Review vasoconstrictor effects versus benefits of inotropes
- Correct metabolic acidosis with sodium bicarbonate 4.2%; give full correction over 6 hr titrating against pH/base excess every 1–2 hr

MANAGEMENT OF PPHN

- Anticipate PPHN in babies with CDH
- Monitor pre and postductal SpO_2
- Calculate oxygenation index (OI) (UAC is a measure of postductal saturation)
- if OI >20 and/or pre:postductal saturation difference >10% discuss with tertiary centre e.g. KIDS NTS to expedite retrieval
- Initiate trial of iNO, 20 ppm for 1 hr
- Magnesium sulfate ($MgSO_4$,) is an effective pulmonary vasodilator, commence an infusion of $MgSO_4$ to achieve serum (Mg) above the normal range (>1 mmol/L)
- **can give rise to profound systemic hypotension**, use only in conjunction with active management of systemic blood pressure support
- Maintain arterial PaO_2 8–10 kPa
- See **Pulmonary hypertension** guideline

GENERAL SUPPORT

- Fluid: restrict to 60 mL/kg/day
- Keep large bore NGT on free drainage and regular aspiration, and nil-by-mouth. Buccal colostrum can be given if available
- Commence parenteral nutrition
- Send blood culture and commence first line antibiotics
- Send clotting screen and correct any abnormalities
- Correct hypocalcaemia
- If antenatal diagnosis of a duct dependent congenital cardiac lesion, or any uncertainty about the presence of cardiac anomaly, commence dinoprostone (prostaglandin E2) 5 nanogram/kg/min
- Maintain magnesium >1 mmol/L
- Maintain normothermia
- Monitor for pneumothorax. See **Chest drain insertion – Seldinger technique** and **Chest drain insertion – Traditional** guidelines
- Crossmatch 1 unit of blood
- Cranial ultrasound scan
- Send blood for chromosomes with parental consent (if not done antenatally)
- Sedation: morphine 10–20 microgram/kg/hr, but avoid deep sedation
- Avoid neuromuscular blocking agents – use is associated with hypoxaemia
- Minimal handling, developmental care with swaddling/cocooning
- Keep area around baby quiet and lights dimmed

COMMUNICATION WITH SPECIALIST CENTRE

- Neonatal consultant to inform planned paediatric specialist centre e.g. Birmingham Children's Hospital/Birmingham Women's Hospital once baby stabilised. This will require conference call with referring consultant, on-call surgeon at specialist centre, neonatologist, PICU intensivist and transport consultant e.g. KIDS NTS, to discuss urgency of transfer and ongoing management
- Undertake transport of babies for surgery only when:
- mean arterial blood pressure normal for gestation
- lactate <3 mmol/L and urine output >1 mL/kg/hr
- ventilation reduced to low pressure settings
- FiO_2 on conventional ventilation 0.5, with preductal saturations 85–95%
- baby fit for surgery and stable for ≥24 hr (may take ≥3–10 days)

EXTRACORPOREAL LIFE SUPPORT (ECLS)

- See **Pulmonary hypertension** guideline
- If ECLS considered refer to specialist centre (e.g. via KIDS NTS team)

USEFUL INFORMATION

- https://bwc.nhs.uk/paediatric-surgery-treatments
- https://kids.bwc.nhs.uk/
- https://www.e-lfh.org.uk/programmes/paediatric-surgery/

CONGENITAL HEART DISEASE: DUCT-DEPENDENT LESIONS [Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions] ● 1/4

INTRODUCTION

- Ductal-dependent congenital heart lesions are dependent upon a patent ductus arteriosus (PDA) to supply pulmonary or systemic blood flow, or to allow adequate mixing between parallel circulations
- Duct-dependent congenital heart disease can be broadly divided into 3 categories

1	Mixing lesions e.g. transposition of great arteries (TGA)	Usually presents as cyanosis ('blue baby')
2	Obstruction to pulmonary circulation e.g. pulmonary or tricuspid atresia, Fallot's tetralogy, critical pulmonary stenosis	Usually presents as cyanosis ('blue baby')
3	Obstruction to systemic circulation e.g. HLHS, critical aortic stenosis, coarctation of aorta, interrupted aortic arch	Usually presents as poor perfusion (shock)

Differential diagnosis of central cyanosis ('blue baby') or persistently low SpO_2 (<95%)

- Cyanosis is the abnormal blue discoloration of skin and mucous membranes

Without echocardiography, clinical distinction between significant persistent pulmonary hypertension (PPHN) and a duct-dependent pulmonary circulation can be extremely challenging. If cause in doubt and echocardiogram cannot be obtained, discuss starting prostaglandin urgently with on-call consultant, as can also be beneficial in PPHN

Cardiac causes of central cyanosis

- Duct-dependent lesions (see above)
- Other cardiac conditions e.g. anomalous pulmonary venous drainage, Fallot's tetralogy, truncus arteriosus etc.

Respiratory causes of central cyanosis

- Persistent pulmonary hypertension
- Other respiratory conditions, e.g. congenital pneumonia, pneumothorax, meconium aspiration, congenital diaphragmatic hernia, respiratory tract obstruction

Other rare causes of central cyanosis

- Methaemoglobinemia

Differential diagnosis of babies presenting with poor perfusion (shock)

Cardiac causes of shock

- Duct-dependent lesion (see above)
- Other cardiac causes e.g. arrhythmias (supraventricular/ventricular tachycardia), cardiomyopathy etc.

Other causes of shock

- Sepsis, bleeding, dehydration, metabolic

RECOGNITION AND ASSESSMENT OF DUCT-DEPENDENT LESIONS

In-utero (antenatal) diagnosis

- If diagnosed in-utero, see management plan in mother's healthcare record
- Deliver at local NNU or NICU equipped for the degree of congenital heart disease. Stabilise before non-urgent transfer to regional paediatric cardiac centre for full cardiology assessment
- For all antenatally diagnosed cases of TGA, antenatal care to be transferred to fetal medicine in a regional NICU attached to the tertiary cardiac centre (e.g. Birmingham Women's Hospital – refer to local pathway) with a plan to be delivered there (as may need atrial septostomy)
- if urgent septostomy indicated e.g. postnatally diagnosed TGA, contact KIDS NTS urgently (see **Transport and retrieval** guideline)
- Neonatal team meet parents pre-delivery
- In some cases of HLHS or complex congenital heart disease, comfort care plan may be in place antenatally – clarify with cardiac team and parents before delivery
- When delivery expected, notify on-call neonatal consultant, NNU and paediatric cardiology team at local referral centre

CONGENITAL HEART DISEASE: DUCT-DEPENDENT LESIONS [Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions] ● 2/4

Postnatal

- Some babies, particularly if left heart lesion developed later in gestation, will present when duct closes
  - can happen at any time during neonatal period and early infancy
  - baby often asymptomatic before duct closes

A baby presenting with cyanosis or shock is a neonatal emergency requiring consultant input. These babies can deteriorate very quickly

Signs of duct-dependent cardiac disease

- Central cyanosis and/or SpO_2 <95%
- Poor perfusion and shock
- Weak or absent femoral pulses
- Usually limited signs of respiratory distress
- Murmur (in some) (see **Cardiac murmurs** guideline)
- Hepatomegaly or other signs of cardiac failure

Investigations

- Chest X-ray
  - oligaemia/plethora/congenital anomaly
  - 'classic' appearance (e.g. 'boot-shaped' heart) is unusual
- Blood gas including lactate
- Echocardiogram if available
- Blood pressure in right upper limb and a lower limb (>20 mmHg difference between upper and lower limb is abnormal)
- Preductal (right upper limb) and postductal (lower limb) saturations (SpO_2 <95% in both limbs or >2% difference is significant) (see **Pulse-oximetry screening** guideline)
- Modified hyperoxia test (carries risk of duct closure: discuss with consultant first) to differentiate between respiratory (parenchymal) and cardiac cause of cyanosis including baseline saturation (and blood gas if arterial line *in situ*)
  - place baby in 100% ambient oxygen for 10 min
  - if there is respiratory pathology, SpO_2 usually rises to ≥95%

IMMEDIATE MANAGEMENT

A suspected cardiac baby presenting collapsed, shocked and/or cyanosed is a challenging neonatal emergency, discuss commencement of prostaglandin infusion urgently with consultant. Discuss urgently with cardiac centre and KIDS NTS (see* Transport and retrieval *guideline)

Immediate post-delivery and resuscitation

- If antenatally diagnosed duct-dependent lesion, tier 2 neonatal staff to be present at delivery
- Do not delay resuscitation of baby if required (see **Resuscitation** guideline)
- Check SpO_2 using pulse oximetry
- Once stable, transfer baby to NNU immediately in transport incubator (if on saturation monitor, SpO_2 75–85% should be acceptable for babies with antenatal diagnosis of duct-dependent cyanotic heart lesion)
  - if cyanotic heart lesions suspected but not confirmed postnatally, manage initially by trying to achieve maximum SpO_2 possible

Stable babies with normal breathing and SpO_2 ≥75% may not require intubation

Management in NNU

- Aim to maintain patency of (or open a closed) ductus arteriosus, and optimise systemic perfusion
- Commence prostaglandin infusion (as per antenatal plan if known) through peripheral IV line, or long line (see **Prostaglandin infusion** guideline)
  - two venous access lines recommended to ensure reliable infusion
- Unless access difficult, avoid umbilical venous line [cardiac centre may need umbilical venous catheterisation (UVC) for septostomy]; if multiple infusions (e.g. inotropes) required, discuss UVC with on-call consultant/cardiac team

CONGENITAL HEART DISEASE: DUCT-DEPENDENT LESIONS [Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions] ● 3/4

- Use **dinoprostone** (prostaglandin E2, prostin E2) (see **Prostaglandin infusion** guideline)
  - start IV infusion at 5–15 nanogram/kg/min as indicated; dose may be increased up to 50 nanogram/kg/min if no response within 1 hr
  - oral dinoprostone used temporarily on very rare occasions when IV access is extremely difficult (see **Neonatal Formulary**)
  - if dinoprostone not available, use prostaglandin E1 (alprostadil) (see **Neonatal Formulary** for dose)
  - make fresh solution every 24 hr
- **Be vigilant**: if apnoea occurs secondary to a prostaglandin infusion, intubate baby but do not reduce infusion dose (see **Intubation** guideline)
- Discuss management with cardiac team at regional paediatric cardiac centre
- Echocardiogram if available
- If any evidence of hypoperfusion (e.g. base deficit >5, lactate >3, hypotension, cool peripheries), give sodium chloride 0.9% 10 mL/kg IV fluid bolus

Monitor

- SpO_2
- Heart rate and ECG
- Blood gases (including lactate) and avoid acidosis
- Blood pressure (preferably using a peripheral arterial cannula – avoid umbilical lines – if UAC required, discuss with on-call consultant)
- Avoid hypothermia

Ventilation (see also Ventilation guidelines)
Indications

- If intubation not needed as emergency, discuss with KIDS NTS/cardiac centre (see **Transport and retrieval** guideline)
- Severe hypoxaemia, acidosis and cardiorespiratory failure
- Apnoea after starting prostaglandin infusion
- dose >20 nanogram/kg/min (review need for such a high dosage in stable baby)
- Features of high pulmonary flow in case of HLHS
- Elective ventilation, if preferred by paediatric cardiologist or retrieval team lead

Technique

- Use sedation/muscle relaxants as needed
- Avoid hyperventilation – can increase pulmonary blood flow
- Use supplemental oxygen judiciously if SpO_2 <75%
- Initial settings: PEEP 4–5 cm H_2O, low mean airway pressure, tidal volume 4–6 mL/kg and FiO_2 0.21, adjusted accordingly
- Aim for:
  - $PaCO_2$ 5–7 kPa
  - PaO_2 4–6 kPa
  - pH 7.30–7.40
  - SpO_2 75–85% (although many will run higher in room air)

Inotropes

- If signs of peripheral under-perfusion, discuss using fluid boluses and inotropes (e.g. dobutamine, milrinone etc.) with cardiac centre
- Arrange local echocardiography (if available) to assess contractility

Restrictive atrial septum

- Signs:
  - severe cyanosis
  - cool peripheries
  - pallor
  - respiratory distress
  - X-ray signs of pulmonary oedema with relatively normal heart size. In contrast, if atrial septum is non-restrictive, pulmonary congestion with cardiomegaly and prominent right heart border is likely

CONGENITAL HEART DISEASE: DUCT-DEPENDENT LESIONS [Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions] ● 4/4

- May require balloon atrial septostomy as an urgent procedure at cardiac centre. If too unstable for transfer or no beds at cardiac centre, discuss with KIDS NTS and cardiac team about the possibility of this emergency septostomy procedure being done by transferring directly to theatres at cardiac centre (see **Transport and retrieval** guideline)
- due to change in septostomy equipment, outreach septostomy not possible in a neonatal unit

High pulmonary blood flow (especially in left-sided lesions such as HLHS)

Presentation

- If there is too much pulmonary blood flow due to pulmonary 'steal' phenomenon, baby may have:
- high or near normal saturations
- metabolic acidosis with a rising lactate
- low blood pressure (especially low diastolic)
- cool peripheries
- tachycardia

Management

- Aim is to improve perfusion and acidosis by balancing systemic versus pulmonary circulation
- Discuss urgently with cardiac centre
- Intubate and ventilate (technique as above)
- Fluid boluses and inotropes as needed

PARENT COMMUNICATION

- It is important that parents are kept informed and updated regularly during management
- Parent leaflets for specific heart conditions are available from British Heart Foundation website www.bhf.org.uk/

CONGENITAL INFECTION ● 1/3

RECOGNITION AND ASSESSMENT

- Request specific investigations for infections associated with clinical features below
- Do not request TORCH serology for intrauterine growth restriction without other indication of congenital infection

Brain
- Intracranial calcifications
- Microcephaly
- Hydrocephaly
- Seizures

Blood
- Disseminated intravascular coagulation
- Cytopenias
- Bleeding
- Lymphadenopathy

Skin
- Vesicular or bullous lesions
- Pustular or scarring lesions
- Petechiae or purpura
- Condylomata lata
- Desquamation (hands and feet)

In-utero
- Intrauterine growth restriction
- Oligo-or polyhydramnios
- Hydrops

Eyes and ENT
- Microphthalmia
- Congenital cataracts
- Chorioretinitis or keratitis
- Sensorineural hearing loss or failed newborn hearing screen
- Haemorrhagic rhinitis
- Saddle nose

Skeletal
- Bony abnormalities
- Limb malformations

System Involvement
- Sepsis
- Myocarditis
- Congenital cardiac anomalies
- Congenital glomerulonephritis

Liver
- Hepatitis
- Hepato- or splenomegaly
- Jaundice
- Ascites

INVESTIGATIONS

- If history of foreign travel in pregnancy, discuss with paediatric infectious diseases. Zika, chargas disease and malaria are recognised congenital problems following travel to relevant areas

Table 1

Clinical scenario	S	C	O			R	T	C	H		
			Parvo-virus B19	Entero-virus	Other			VZV	HSV	HIV	Hepatitis B/C
Abnormal brain development	✓	✓	✓	-	✓	✓	✓	✓	✓	-	-
Sepsis	✓	✓	-	✓	✓	-	✓	✓	✓	-	-
Petechiae/purpura, hepatosplenomegaly	✓	✓	✓	-	-	✓	✓	✓	✓	-	-
Blisters	✓	✓	-	-	-	✓	-	✓	✓	-	-
Intrauterine growth restriction	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-
Abnormal antenatal scans*	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	-
Eye disease	✓	✓	-	-	✓	✓	✓	✓	✓	-	-
Hearing loss	✓	✓	-	-	✓	✓	✓	✓	✓	-	-
Limb abnormalities	✓	-	-	-	✓	✓	-	✓	-	-	-
Cardiac abnormalities	✓	-	-	✓	✓	✓	-	-	-	-	-
Liver abnormalities	✓	✓	-	✓	-	✓	✓	-	✓	-	-
No antenatal booking bloods**	✓-	-	-	-	-	-	-	-	-	✓	✓

* Periventricular calcification, hyperechogenic bowel, ventriculomegaly, microcephaly, fetal growth restriction, hydrops

** URGENT sample required: HIV, syphilis (paired – not cord blood), hepatitis B serology

Key

S	Syphilis
C	Cytomegalovirus
O	Other
R	Rubella
T	Toxoplasmosis
C	Chicken pox
H	Herpes simplex and other blood borne viruses

Specific investigations

- Send placental samples for histopathology and microbiology/virology stating 'suspected congenital infection'

Syphilis

- See **Syphilis – babies born to mothers with positive serology** guideline for investigations and management

CMV

- See **CMV** guideline for investigations and management

Other

Parvovirus B19

- Severe anaemia or hydrops
- Maternal serology
- PCR: blood

Enterovirus

- PCR: blood, NPA/nasal secretions, skin lesions if appropriate

CONGENITAL INFECTION ● 3/3

Malaria

- Weekly blood film for 4 weeks

Rubella

- PCR: blood and saliva
- Audiology and ophthalmology review

Toxoplasmosis

- Paired maternal/infant serology (not cord blood)
- Add serology to booking bloods
- PCR: neonatal blood, placenta
- Placental microscopy
- Cranial US +/- MRI head
- Audiology and ophthalmology review

Chickenpox (VZV)

- See **Fetal varicella syndrome** section of **Varicella** guideline

HSV, HIV, Hepatitis, HTLV-1

- See **Herpes simplex virus (HSV), Human immunodeficiency virus (HIV)** and **Hepatitis B and C** guidelines

If high clinical suspicion or positive results refer to paediatric infectious diseases

CONJUNCTIVITIS ● 1/2

Conjunctivitis is a potentially blinding condition with associated systemic manifestations

RECOGNITION AND ASSESSMENT

- Conjunctival redness
- Swelling of conjunctiva and eyelids
- Purulent or mucopurulent discharge
- Vesicles on lids or adjacent skin (herpes simplex)

Differential diagnosis

- Sticky eye with blocked tear duct in which there is no inflammation of conjunctiva
- Congenital glaucoma in which there is corneal opacity
- Swelling of conjunctiva and eyelids as part of preseptal or orbital cellulitis

AETIOLOGY

Bacterial

- *Staphylococcus aureus*
- *Haemophilus influenzae*
- *Streptococcus pneumoniae*
- *Serratia spp*, *E. coli*, *Pseudomonas spp*
- *Neisseria gonorrhoeae* – typical onset aged 0–5 days: mild inflammation with sero-sanguineous discharge to thick, purulent discharge with tense oedema of eyelids
- *Chlamydia trachomatis* – typical onset aged 5–14 days: mild-to-severe swelling with purulent discharge (may be blood-stained)

Viral

Herpes simplex virus (HSV)

MANAGEMENT

4–6 hrly eye toilet using sodium chloride 0.9%

- cooled, boiled tap water acceptable for home use

Conjunctivitis (see signs above)

- Swab all for:
  - Gram stain and bacterial culture and sensitivities
  - if other suspicions of HSV (e.g. vesicles etc.), swab for HSV PCR
    - use dry swab/moistened with viral transport media
    - place in dry tube/pot
    - use specific nucleic acid amplification test (NAAT) swab for *Chlamydia trachomatis* and *Neisseria gonorrhoeae* PCR
- Treat both eyes with:
  - frequent eye toilet as necessary
  - *Staphylococcus aureus:* fusidic acid 1% eye drops twice daily
  - otherwise: chloramphenicol 0.5% eye drops (every 2 hr for first 48 hr, followed by 3-4 times daily)
- Presentation ≤24 hr of birth suggests gonococcal infection – inform consultant paediatrician
- If herpes suspected, begin treatment with aciclovir IV 20 mg/kg 8-hrly and aciclovir eye ointment (applied 5 times daily) while awaiting results

SUBSEQUENT MANAGEMENT

In severe non-resolving cases

- Take throat and eye swabs for viral PCR
- If herpes suspected, look for other signs of herpetic infection
- Treat suspected herpes with aciclovir IV and topical for 14 days
- Refer to ophthalmology

***Neisseria gonorrhoeae* suspected**

- Request urgent Gram stain and culture
- Assess baby for sepsis
- Swab for PCR
- Give single dose cefotaxime 100 mg/kg IV
- Refer to ophthalmology

CONJUNCTIVITIS ● 2/2

Chlamydia

- If result positive treat:
  - oral erythromycin 14 days
- If maternal chlamydia treated successfully in pregnancy, baby does not require prophylactic treatment
  - if unsure, swab baby's conjunctiva using NAAT swab
  - if high risk, send bacterial swab for gonococcus and HIV antibody, HBsAg and HCV antibody from mother or baby

Gonococcal or chlamydia infection detected

- Refer mother and partner to genitourinary medicine for immediate treatment

CONSENT ● 1/3

Based on BAPM Consent in Neonatal Clinical Care: Good Practice Framework (2004) | British Association of Perinatal Medicine (bapm.org)

FOR COMMON NEONATAL INVESTIGATIONS, INTERVENTIONS AND TREATMENTS

- The following guidance is taken from 'Good practice framework for consent in neonatal clinical care' produced by the British Association of Perinatal Medicine (BAPM)
- It is a legal and ethical requirement to gain valid consent before examining and initiating any investigation or treatment for any patient
- Consent is obtained from someone with parental responsibilities:
  - if married, parents
  - if not married, mother but not father, unless father has acquired parental responsibility via a court order, being registered on birth certificate or parental responsibility agreement
  - a legally appointed guardian
  - a local authority designated in a care order or holding an emergency protection order
- Consent is valid only when information has been understood by the parents and explains why the intervention is recommended, its risks and implications, and other options should consent be withheld

Documentation of information given and parents' understanding and agreement to proceed is the most important validation of consent. A signature does not in itself confirm informed consent

- Witness consent wherever possible, and record name of witness
- In neonatal practice, there are frequent occasions when no one is available to provide valid consent and treatment is initiated in its absence (e.g. emergency ABC resuscitation, stabilisation, chest drainage or exchange transfusion when delayed treatment would not be in baby's best interests, or following maternal general anaesthetic when mother is unmarried to baby's father). It should always be possible later to justify the action to the parents and to reassure them that it was in the baby's best interests

GOOD PRACTICE

- Give parents of babies admitted to NNU written information (BLISS https://www.bliss.org.uk/health-professionals/information-and-resources/resources-for-parents) describing low-risk procedures such as venesection, for which explicit consent is not normally sought
- Give parents information leaflet for data collection, allowing them to opt out
- Procedures that need to be done as an emergency may still carry risk and parents need to be fully informed about them and the likelihood of repeat procedure at the first suitable opportunity
- For more detailed information see **BAPM Framework for enhancing shared decision making** (https://www.bapm.org/resources/158-enhancing-shared-decision-making-in-neonatal-care)

LEVELS OF CONSENT

- Level of consent sought to be appropriate to situation
  - in an emergency, it is reasonable and lawful to provide treatment without information disclosure/consent from parents at the time – action considered to be in baby's 'best interest'
- When possible, parents to be given adequate time to consider their views on non-emergency treatments
- Procedures can be divided into different levels of consent; implicit, explicit verbal or explicit written, depending on risk-benefit ratio

Implicit consent

- Where the nature and risk of the procedure is such that a less formal transfer of information is considered sufficient, and often retrospective
- List of investigations, procedures and treatments is long – see **Table 1** for examples

Explicit consent

- Also referred to as 'express' or 'direct' consent
- Involves discussion regarding purpose and risks of an intervention formally explained and consent, either verbal or written, obtained before intervention
  - must be recorded in patient notes
- Recommended for:
  - moderate-high risk procedures
  - close risk-benefit ratios

- surgical procedures
- See **Table 1**

Table 1

Procedure	Explicit consent not USUALLY required	Explicit consent recommended
Examination and investigations		
Examining and assessment of the patient	✓	
Clinical photographs and video-recordings		✓
Routine blood sampling	✓	
Blood culture	✓	
Lumbar puncture:		
diagnostic	✓	
therapeutic		✓
Supra-pubic aspiration of urine	✓	
Screening of babies and/or their mothers in high-risk situations with no prior knowledge of maternal status e.g. suspected HIV or substance abuse		✓
Screening for infection in response to positive results of maternal screening e.g. known maternal HIV or substance abuse	✓	
CMV, toxoplasma, rubella and herpes screening	✓	
Genetic testing (including karyotype)		✓
Portable X-rays and ultrasounds	✓	
Gastrointestinal imaging involving contrast		✓
Procedures involving the baby leaving the unit		
X-rays	✓	
ultrasound	✓	
videoflouroscopy	✓	
MRI/CT with or without contrast		✓
EEG/CFAM	✓	
EEG with video recording		✓
ECG	✓	
ROP screening	✓	
Practical procedures		
All surgical procedures		✓
Umbilical arterial or venous catheterisation	✓	
Percutaneous arterial lines	Radial, ulnar or pedal	Brachial or femoral
Percutaneous long lines (including use of contrast medium to visualise tip)	✓	
Peripheral venous lines	✓	
Nasogastric/nasojejunal tubes	✓	
Tracheal intubation	✓	
Ventilation/CPAP	✓	
Chest drain insertion and replacement		These procedures usually need to be done as an ✓
Abdominal drainage for		✓

perforation of ascites		emergency. However, they carry risk and parents need to be fully informed about them and the likelihood of repeat procedure at the first suitable opportunity	
Irrigation following extravasation injury			✓
Urethral catheterisation	✓		
Peritoneal dialysis		✓	
Bone marrow aspiration		✓	
Any biopsy		✓	
Treatments			
Blood transfusion	✓		
Use of pooled blood products	✓		
Exchange transfusion		✓	
Partial exchange transfusion	✓		
Antibiotics	✓		
Vitamins/mineral supplements	✓		
IV fluids	✓		
Parenteral nutrition	✓		
Surfactant	✓		
Anticonvulsants	✓		
Sedation for intubation and ventilation	✓		
Inotropes	✓		
Indomethacin or ibuprofen for patent ductus arteriosus	✓		
Prophylactic indomethacin	✓		
Parenteral and oral vitamin K for babies admitted to NNU	✓		
Vitamin K for normal term babies		✓	
Nitric oxide for term babies	✓		
Nitric oxide for preterm babies		✓	
Dexamethasone for chronic lung disease		✓	
Postnatal dexamethasone for laryngeal oedema	✓		
Immunisation		✓	
Treatment for retinopathy of prematurity		✓	
Nutrition			
Breast milk fortification	✓		
Use of donor breast milk		✓	

Explain all investigations, procedures and treatments to parents at earliest opportunity

DOCUMENTATION

- Documentation, supported by a signature for written explicit consent
- Documentation of oral explicit consent
- Provide parents with information sheets

Parental consent for inclusion of neonates into participating research projects must comply with project description. Study approvals etc. for the participating unit to be overseen by relevant research and development team of NNU's Trust

CONTACTING A CONSULTANT ● 1/2

The need to call for consultant support may vary with the experience of the staff involved. This guideline suggests scenarios where advice of a consultant should normally be sought. However the list is not exhaustive and **consultant advice should be sought any time that the junior medical team and/or experienced nurses feel the need for support**

Initiate life saving measures, e.g. intubation, before informing consultant

*** Consultant normally expected to attend in person**

Before birth
- Delivery <27 weeks' gestation*
- Unexpected birth of baby with congenital diaphragmatic hernia*
- If stated in neonatal alert form/antenatal MDT plan

During resuscitation
- No heart beat at 5 min/continuing resuscitation at 10 min*
- Request of consultant obstetrician

Admission
- <28 weeks' gestation
- Ex-utero intensive care transfer
- Cord pH <7.0 and/or 10 min Apgar score <6
- Suspected subgaleal haemorrhage

Inpatient
- FiO_2 >0.6 with/without respiratory support
- Baby who has required endotracheal ventilation (do not wait for consultant before intubating and initiating ventilation)
- Anticipated need for HFOV
- PPHN likely to need nitric oxide*
- Continuing hypotension despite volume expansion and dobutamine and dopamine*
- Seizures
- Neonatal encephalopathy requiring therapeutic hypothermia
- Severe jaundice
- bilirubin above exchange level
- bilirubin rising >8.5 micromol/L/hr despite intensive phototherapy
- Major deterioration
- Baby with ambiguous genitalia/disorder of sexual development
- Major congenital anomaly without antenatal plan
- Renal failure with serum K^+ >7 mmol/L or Na^+ <120 mmol/L
- Known subgaleal haemorrhage with haemodynamic instability needing volume or blood products replacement*
- Unexpected death*
- Initiation of, or unexpected withdrawal of, intensive care*
- Escalation level requiring in-utero or ex-utero transfers out or refusals from other units
- Tier 2 staff and nursing team cannot agree management plan for baby
- Inability immediately to site essential line*

COMMUNICATING WITH CONSULTANT

- If immediate attendance required, state this first
- Communicate essential details using Situation-Background-Assessment-Recommendation-Decision (SBARD) communication tool

Situation
- State who you are and where you are calling from
- State patient's name and reason for your call
- Describe your concern

CONTACTING A CONSULTANT ● 2/2

Background

- Collect information from patient's chart and notes before calling
- Give overview of patient's background
  - admission diagnosis
  - date of admission
  - previous procedures
  - current medications
  - pertinent laboratory results
  - other relevant diagnostic results

Assessment

- Vital signs
- Clinical impressions/concerns
  - think critically, considering what might be the underlying reason for patient's condition
  - it may be "I'm not sure what the problem is, but I am worried"

Recommendation

- State your recommendation (in an urgent situation you may start with this)
- Explain what you need. Be specific about request and time frame
- Make suggestions
- Clarify expectations

Decision

- Clarify what has been agreed, who is going to do it, and what the next steps will be, e.g., 'We have agreed that you will do XX in the next YY hours and I will do ZZ' or 'if there is no improvement within XX, I will do YY'
- Repeat any plans agreed to ensure accuracy

CRANIAL ULTRASOUND SCANS ● 1/3

PURPOSE

- To detect:
  - brain injury in at-risk babies to provide appropriate medical management
  - lesions associated with long-term adverse neurodevelopmental outcome

PRETERM BABIES

Indications

- Gestation <33 weeks
- Birth weight <1500 g
- Ventilated
- Abnormal neurology
- Abnormal clotting
- Congenital abnormalities/significant dysmorphic features
- Cranial malformation suspected antenatally/family history of cranial malformations
- Maternal cocaine use in pregnancy and head circumference <10th centile and lower centile than weight
- Micro/macrocephaly

Minimal schedule for scans:

Gestation					
<30 weeks	0–3 days		6–10 days	14–16 days	36 weeks CGA or at discharge
30–32 weeks		3–7 days			36 weeks CGA or at discharge

Additional scans

- If routine scans show a significant abnormality, discuss serial scanning with consultant
- Perform additional scans as clinically indicated or following a significant clinical event:
  - necrotising enterocolitis
  - major collapse
  - repeated severe episodes of apnoea and bradycardia
  - unexplained sharp fall in Hb
  - change in neurological status
  - abnormal head growth
  - pre- and post-operatively

Follow-up

- If scan abnormal further follow-up as advised by consultant

TERM/NEAR TERM BABIES

Indications

- Neonatal encephalopathy/ischaemic brain injury
- Seizures
- Abnormal neurological signs (e.g. floppy child, large head)
- Congenital abnormalities (except trisomy 21) e.g. congenital cardiac abnormality, congenital diaphragmatic hernia
- Unexplained poor feeding at term
- Unexplained hypoglycaemia, looking for pituitary and midline structures
- Meningitis
- Congenital viral infection
- Metabolic disorders
- Suspected brain malformations
- Significant maternal alcohol intake during pregnancy
- Requiring ventilation – including all babies having surgery under general anaesthetic

Seizures

- In term babies with seizures, perform cranial ultrasound on admission while waiting for MRI scan (preferred imaging modality)

Neonatal encephalopathy

- Initial scan within 24 hr

- 2nd scan 3–4 days
- 3rd scan 7–14 days
- In encephalopathic babies with significant birth trauma and low haematocrit, request non-contrast CT scan to exclude extra-axial bleed
- For babies with moderate-to-severe encephalopathy, ultrasound ≤12 hr of presentation

PROCEDURE

Operator must achieve acceptable level of competence before performing and reporting scans independently

- Record minimum set of coronal images (6+):
- anterior to frontal horns of lateral ventricles
- at anterior horns of lateral ventricles and Sylvian fissures
- at 3rd ventricle and thalamus
- at posterior horns of lateral ventricles (with choroids)
- posterior to choroids (posterior brain substance)
- if lateral ventricles are dilatated, measure ventricular index at the level of 3rd ventricle at the foramen of Munro (ventricular index) and plot on appropriate chart
- Record minimum set of sagittal images (5+):
- midline through 3rd ventricle, cavum septum pellucidum, cerebellum with 4th ventricle and foramen magnum
- through each lateral ventricle showing anterior and posterior horns, with caudothalamic notch imaged if possible
- through each hemisphere lateral to the ventricle for deep white matter
- Supplemental oblique, surface and axial images may be necessary to record pathology
- For detection of cerebellar lesions, scanning through posterior fontanelle (junction of lambdoid and sagittal sutures) and mastoid fontanelle (junction of posterior parietal, temporal and occipital bones) can be useful

SCAN REPORTING

- Must be done by appropriately trained staff
- Scans must be reported using categories/terminology in **Table** below
- Consider further imaging e.g. MRI scan or, if ultrasound abnormal, CT scan of brain

Intraventricular haemorrhage	• None • Localised IVH without dilatation (germinal matrix haemorrhage, subependymal haemorrhage) • IVH with ventricular dilatation • Large IVH with parenchymal infarction
Ventricular size	• Normal • Enlarged (measure and plot ventricular index)
Parenchymal lesions	• None • Periventricular flare • Cystic lesions ◦ single large porencephalic cyst ◦ multiple cysts (cystic periventricular leukomalacia)

COMMUNICATION

- Any member of neonatal team may communicate a normal result to parents but it is vital to give a consistent interpretation. N**ote** that a normal scan does not equate to normal development and follow-up is essential
- Discuss an abnormal result with neonatal consultant before discussion with parents – an abnormal scan does not equate to abnormal development, follow-up is essential

DOCUMENTATION

- Documentation is extremely important. Save copies as per unit policy for future review/reference/comparison – each image must contain patient identifiers
- Record following information on investigation chart:
- date scan requested

CRANIAL ULTRASOUND SCANS ● 3/3

- date scan carried out
- Record ultrasound result (or file a written report) in baby's notes (neonatal staff)
- Complete cranial ultrasound ad hoc form in **BadgerNet**
- Record plan for performing future scans
- Record in notes any discussion with parents, especially of abnormal scans
- Include results of all scans in discharge summary, even if normal
- If eligible baby transferred to another hospital before scanning, communicate need for scan in transfer summary

CYTOMEGALOVIRUS (CMV) ● 1/3

MATERNAL TESTS

- In-utero transmission of CMV can occur during primary maternal infection, reactivation, or reinfection of seropositive mothers
- CMV serology (IgG and IgM) tests are not conclusive
- If CMV suspected, test baby at birth
- Involve paediatric infectious diseases in fetal medicine discussion
- Both IgG and IgM negative: unlikely to be CMV infection
- IgG negative at booking, then IgG positive later in pregnancy: new infection
- IgG positive, IgM negative: past maternal infection
- IgG positive, IgM positive: check CMV IgG avidity
  - if low avidity likely to be maternal CMV infection within last 3–4 months

Antenatal ultrasound

Features include:

- IUGR
- Intracranial ventriculomegaly/calcification, microcephaly, periventricular leukomalacia
- Hyperechoic ('bright') bowel
- Ascites, hydrops fetalis
- Pleural or pericardial effusions
- Oligo- or polyhydramnios
- Hepatomegaly
- Abdominal calcification
- Pseudomeconium ileus
- Thickened placenta

NEONATAL FEATURES

Indications for testing

- Evidence of maternal primary CMV infection in pregnancy
- Antenatal ultrasound suggestive of congenital CMV (cCMV)
- Petechiae/purpura
- Hepatosplenomegaly
- Prolonged or conjugated hyperbilirubinaemia with transaminitis
- Unexplained thrombocytopenia
- Microcephaly
- Intracranial calcification or ventriculomegaly
- Chorioretinitis
- Seizures with no other explanation
- Severe pneumonia
- Cataract
- Failed hearing screen
- Postnatally acquired acute CMV in extreme premature baby:
  - sepsis
  - necrotising enterocolitis
  - pneumonitis

Investigation results

- CMV PCR mouth swab
  - soak mouth swab in saliva for at least **1 min**; send in viral transport medium to regional laboratory
  - if high-risk CMV send urine

Other congenital infection screen depending on features (not exclusive):

- Toxoplasma (hydrocephalus, microcephaly, convulsions, generalised infection)
- Syphilis (rash, rhinitis, hepatosplenomegaly, jaundice, thrombocytopenia)
- Rubella (cataract, deafness, microcephaly)
- Zika (maternal/paternal travel, microcephaly)

CMV POSITIVE

Further investigations

- Full blood count, liver enzymes, bilirubin, renal function

- Blood CMV viral load
  - if unknown whether infection is congenital request initial bloodspot card to be tested for CMV PCR
- Ophthalmic assessment
- Audiology: brainstem-evoked response – urgent (to offer treatment by aged 4 weeks)
- Head ultrasound
  - if ultrasound head abnormal or seizures, MRI head

TREATMENT

- Postnatal acquired CMV – no treatment

Mild cCMV

- Asymptomatic **–** no CNS involvement, including sensorineural hearing loss
  - isolated IUGR
  - hepatomegaly with normal liver enzymes
  - isolated raised ALT/AST
  - mild thrombocytopenia
- No treatment

Moderate cCMV

- Discuss with infectious diseases specialist if:
  - >2 weeks mild features
  - >2 mild features

Severe cCMV

- Significant organ involvement:
  - significant liver enzyme abnormalities
  - marked hepatomegaly
- Any CNS disease
  - isolated sensorineural hearing loss
  - retinitis
  - microcephaly
  - cranial ultrasound or MRI brain abnormalities
- Treat: valganciclovir 16 mg/kg oral 12-hrly for 6 months if **not** tolerating oral feeds, ganciclovir 6 mg/kg IV [prepared by pharmacy (cytotoxic)] infusion over 1 hr, 12-hrly for maximum 6 weeks (switch to oral as soon as possible)
  - **NOTE** dose reductions required in renal impairment
- Discuss side effects vs benefits with parents:
  - **advantages**: potential reduced risk of deafness and developmental delay
  - **disadvantages**: during treatment reversible blood dyscrasia; long-term unknown risk to fertility and malignancy
- Start treatment as soon as possible
  - if diagnosis delayed can be started aged ≤1 month

FEEDING

- Do not discourage infected women from breastfeeding their own uninfected, term babies (CMV can be transmitted via breastfeeding, but benefits of feeding outweigh risks posed by breastfeeding as a source of transmission)
- Avoid breastfeeding of premature baby if mother is positive and baby asymptomatic
- If concern (e.g. pre-school siblings), consider screening mother or breast milk

FOLLOW-UP

- Enter on CMV surveillance register (discuss with paediatric infectious diseases specialist)
- Ganciclovir IV: FBC, LFT, U&E at least twice weekly
- Valganciclovir oral: FBC, LFT, U&E weekly for first 4 weeks, then monthly until completion
- Audiology: 3 monthly for first year, then 6 monthly for 3 yr, then annually until aged 6 yr for both asymptomatic and symptomatic congenitally infected babies
- Paediatric infectious diseases specialist: as soon as possible in first month, then annually until aged 2 yr
- Ophthalmology: at least annually until aged 5 yr if symptomatic/signs at birth
- Neurodevelopmental assessment: aged 1 yr
  - if delayed development discuss MRI brain with radiology

CYTOMEGALOVIRUS (CMV) ● 3/3

- Complex cases discuss at congenital CMV network monthly virtual clinic (email: imperial.ccmvclinic@nhs.net (discuss with paediatric infectious diseases specialist)

DEATH AND SERIOUSLY ILL BABIES ● 1/2

Consultant must be involved immediately in the care of a seriously ill baby

GUIDANCE

Preparation

- Most neonatal deaths are anticipated and often occur following withdrawal of intensive care. The neonatal staff in conjunction with the parents should plan the care of the baby around death
- If an unwell baby's condition deteriorates seriously, discuss immediately with on-call consultant
- On-call consultant will assess the situation with nursing and medical team, ensuring thorough documentation

Discussion with parents

- If death is inevitable, consultant will discuss with parents
- Ensure baby's nurse is present and document discussion in detail
- Use Royal College of Paediatrics and Child Health **Making decisions to limit treatment in life-limiting and life-threatening conditions in children: a framework for practice** as appropriate – see https://adc.bmj.com/content/100/Suppl_2/
- If appropriate and local policy, review baby for organ donation
- discuss with organ donation team before approaching parents
- further guidance available via https://www.odt.nhs.uk/deceased-donation/best-practice-guidance/paediatric-care/
- If organ donation not appropriate or considered, then ask parents if they wish a religious or spiritual person to be involved
- Complete the West Midlands Neonatal Operational Delivery Network Integrated Comfort Care Pathway (ICCP) https://www.teamwmcn.nhs.uk/neonatal-guidelines. This document:
- acts as a record of events and a guide for palliative care
- contains useful links for further information
- Complete ReSPECT form – can work in conjunction with any advanced care plans
- If transfer home or to a hospice, complete advance care plan, as dictated by local team/hospice
- If death is sudden and unexplained, follow sudden unexpected death in childhood (SUDIC) guidelines and consult with on-call SUDIC consultant where necessary West Midlands Safeguarding Children Group (procedures.org.uk)

Second opinion when withdrawal of care not agreed

- If there is disagreement amongst the MDT or between the team and the parents, consultant to seek second opinion from a colleague

Further support

- If parents do not accept second clinical assessment:
- discuss with medical director or deputy
- discuss with parents the option of a further opinion from consultant neonatologist from another unit in neonatal network
- Consultant may wish to seek advice from Trust's legal advisers via medico-legal department or on-call manager
- Timescale for events in individual babies may vary from <24 hr to >1–2 weeks

Saying goodbye

- Consider an appropriate place of care for baby, including transfer to a hospice if available/appropriate and parents' preference
- Parents may request a blessing or ceremony by a religious representative or family member
- Ensure all family members are allowed time and privacy with baby
- Offer parents an opportunity to take photographs of baby if they wish
- Provide a keep-sake box that can include photos, hand and foot prints, lock of hair, cot card, etc.
- Offer parents opportunity to wash, dress and prepare baby
- A small toy or other memento may accompany baby to mortuary

DEATH

- When a baby dies there are formalities to be completed. These should be handled as sensitively as possible to minimise emotional trauma to parents, whose wishes should be respected and who should be guided carefully through the necessary procedures

DEATH AND SERIOUSLY ILL BABIES ● 2/2

- Following notification of baby's death from attending nurse, a doctor or ANNP (if trained to do so) should confirm the death and make a suitable entry in the case notes with date and time of confirmation of death
- If the death was sudden and unexpected (e.g. resuscitation failure in delivery suite or in the A&E soon after arrival):
  - if no radiological confirmation of position of ETT, another practitioner must verify position on direct laryngoscopy before removal, and the depth of insertion (from lips or nostril) should be recorded. A post-mortem X-ray is not necessary for such confirmation
  - similarly, leave all central vascular catheters and drains *in situ* after cutting short and covered with dressing (see The SUDIC Protocol - RCEMLearning)
- If birth has not been registered confirm with parents what this will be and ensure that it appears on all subsequent documentation (including death certificate, if issued)

Formal arrangements

- Neonatal staff will offer advice about registration and funeral arrangements with back-up support from hospital general office/bereavement office
- Involve bereavement midwife early if available
- In some areas, all deaths must be discussed with Coroner's officer. Check the requirements of your local Coroner before issuing death certificate and requesting post-mortem consent
- If you are unable to issue death certificate, a senior clinician must report the death to the Coroner
- If death certificate can be issued:
  - parents make an appointment with Registrar of births and deaths to deliver death certificate, unless Coroner's officer recommends otherwise
- Registrar of births and deaths will issue certificate of authority for burial or cremation, which should be given to:
  - hospital general office if hospital is burying baby
  - funeral director handling burial if parents are making their own arrangements

Post-mortem

- Offer a post-mortem in all babies not requiring investigation by the Coroner. It is the parents' right to have this choice
  - give parents an information leaflet to assist their choice
  - if case required Coroner investigation, Coroner determines need for post-mortem and parents cannot choose
- Post-mortem request must come from tier 2 staff /consultant and a witness must sign the fully completed consent form
  - send original form to mortuary with baby, place copies in baby's hospital notes together with copy of death certificate
  - death summary must be completed by tier 2 staff/consultant within ≤24 hr of death
  - copy of death summary must be sent to mortuary to accompany baby having a post-mortem

Baby transfer

- Special arrangements will be made to transport baby to mortuary according to local hospital policy; allow parents to accompany baby if they wish
  - some may prefer to see baby on the NNU if possible or chapel of rest
- Unless the Coroner is involved, parents may take baby's body directly from the NNU, once appropriate documentation has been completed (see SANDS website – www.sands.org.uk/). Where babies are taken will depend upon religious belief of parents or on whom they have designated as funeral director. In all cases strict adherence of local hospital policy must apply

Parent support

- Offer bereavement support information (e.g. SANDS, Child bereavement UK, ACT) or counsellor
- Consultant will offer bereavement counselling at 6–8 weeks, or following final post-mortem result
- Arrange appointment with trained bereavement nurse/midwife specialist if available

Communication

- Inform named obstetrician and neonatology consultants at referring hospital (if appropriate), GP, health visitor, and community midwife that death has occurred. (See **Death guideline checklist** https://www.teamwmcn.nhs.uk/neonatal-guidelines
- Document this in notes or on local checklists
- Ensure any pending appointments or referrals are cancelled
- Follow local guidelines for notifying child death and completion of form A and B for death reviews (legal requirement)

DELAYED CORD CLAMPING ● 1/2

- Current evidence suggests delayed cord clamping (DCC) is safe and can confer benefits to term and preterm babies
- supporting transition to extra-uterine life
- associated with improved neonatal outcomes and reduced mortality
- ILCOR, RCOG, NICE, Resuscitation Council (UK) and WHO all recommend DCC for ≥1 min in stable babies, but state that resuscitation should take priority in unstable babies

INDICATIONS

- Beneficial for all babies (especially preterm)
- When immediate resuscitation required, resuscitation with intact cord can be performed (if appropriate equipment available)

CONTRAINDICATIONS

- Monochorionic twins
- Conditions where placental circulation is not intact, including:
- placental abruption
- bleeding placenta praevia
- bleeding vasa praevia
- cord avulsion
- Antenatally diagnosed congenital abnormalities that may require medical intervention immediately after birth e.g.:
- congenital diaphragmatic hernia
- gastroschisis
- CCAM with thoraco-amniotic shunt
- Babies at high risk of a blood-based infection (e.g. newly diagnosed HIV or hepatitis)
- most mothers who have low viral loads can safely have DCC
- Acute maternal obstetric emergency
- Baby requires immediate resuscitation

EQUIPMENT

- Neopuff™
- Single patient use face mask
- Suction
- Plastic bag
- Thermometer/temperature monitoring equipment
- If available, platforms, e.g. LifeStart™ or Concord® trolley allow for assisted transition and stabilisation of babies whilst allowing for DCC

PROCEDURE

Pre-delivery

- Discuss benefits and risks of DCC with parents in antenatal appointments and before delivery
- Provide parents with:
- opportunity to ask questions
- parental information leaflet
- Parents have a choice to decline DCC − decision should be respected and supported by the team
- Discuss plan for DCC with intact cord stabilisation with midwife/obstetrician before delivery

During delivery

- Babies born to parents who have consented to DCC to receive ≥1 min of DCC, unless clinically contraindicated

Milking of the cord contraindicated and associated with increased incidence of severe IVH in preterm babies <28 weeks' gestation

- Babies ≥28 weeks', if DCC not possible, umbilical cord milking recommended
- Following delivery, dry and wrap baby, or if <32 weeks' gestation and hat applied, place immediately into plastic bag
- **Vaginal birth:** hold baby below level of perineum, or if appropriate, place baby skin-to-skin with mother following drying and stimulation

- use pre-warmed towels from resuscitaire to keep baby warm
- **Caesarean section delivery:** hold baby below level of incision site
- prevent heat loss, e.g. place sterile towel over baby, whilst allowing for drying and stimulation
- Where facilities (e.g. LifeStart™ or Concord® trolley) available, assisted transition and assessment may be commenced while undergoing DCC
- commence stabilisation as per NLS guidelines (see **Resuscitation** guideline)
- If deemed more appropriate by obstetric/neonatal team (i.e. in situations where cord is very short) and baby seen to be vigorous − perform DCC without equipment
- may not allow assessment of heart rate, tone etc. during initial minute
- Babies born within intact amniotic sac:
- placental circulation is interrupted
- delay cord clamping until cord pulsations stop or up to 1 min if baby is vigorous
- deliver baby into cot
- rupture sac
- if preterm, place baby in plastic bag and transfer to resuscitaire
- if cord pulsations stopped, clamp cord
- If baby requires intubation/chest compressions, ask for umbilical cord to be cut immediately and commence NLS stabilisation
- Do not delay administration of prophylactic syntocinon

AFTERCARE

- Record timing of cord clamping in medical notes

COMPLICATIONS

- Jaundice requiring phototherapy (usually mild)
- Hypothermia

DEVELOPMENTAL CARE ● 1/2

INTRODUCTION

- Developmental needs are an integral part of care planning; these differ according to gestational age, postnatal age and health status. Assess developmental needs and plan care responsive to baby's stress threshold and sleep/wake pattern

Key concepts

- Promoting organised neurobehavioural and physiological function
  Altering the physical environment to protect vulnerable developing sensory systems
  Family-centred care

Goals

- Improved physiological stability
- Reduced stress and pain
- Appropriate sensory experience
- Protection of postural development
- Improved sleep patterns
- Improved feeding
- Confident parenting and attachment
- including improvement for parents'/carers' mental wellbeing – reduction of stress levels, anxiety and depression
- Staff satisfaction
- Improved neurodevelopmental outcomes
- Help with breastfeeding
- Possible reduced length of stay

OBSERVATION AND RECOGNISING BEHAVIOURAL CUES

- Recognition of signs that baby may be experiencing stress is vital. Babies will display different cues at different stages of development according to their behavioural state (wake/sleep state)

Defensive/avoidance behaviour	Coping/approach behaviour
• Any of the following indicate baby may need help or some time-out: • respiratory pauses, tachypnoea, gasping • yawning, sighing • gagging, posseting • hiccoughing • sneezing • coughing • straining • flaccidity (limp posture) trunk, limbs, face, mouth • hypertonicity with hyperextension (stiff posture) • arching • finger splays, 'high guard hands', 'saluting' • hand-on-face, fisting • facial grimace • Frantic diffuse motor activity: • squirming • disorganised transition between and rapid changes of behavioural state • fussing or irritability • staring or gaze averting • hyper alertness • crying/whimpering	• The following may indicate how well baby is able to settle itself, cope with interventions and to interact: • able to regulate colour and breathing pattern • reduction of tremors, twitches and autonomic stress cues • smooth well-modulated posture and normal tone • smooth movements • hand and foot clasping • grasping • hand-to-mouth activity • hand holding • hands to midline • rooting/sucking • defined sleep states • focused, shiny-eyed alertness or animated facial expression • 'ooh' face • cooing • attentional smiling • easily consoled

CARE-GIVING AND INTERVENTIONS

- Handling and invasive procedures may cause:
  destabilisation of blood flow, cardiac regulation, oxygenation and digestive functions
- discomfort, pain and iatrogenic injury
- poor thermoregulation
- disrupted growth

- altered sleep patterns with disordered transition between states
- delay in development of normal movement and posture
- diminished parental confidence and competence

Whenever possible all care-giving and intervention should be carried out by 2 people, 1 person performs the intervention; the other provides the baby with comfort and support

Aim	Method
• Plan and deliver individualised care and interventions (nursing and medical), in accordance with baby's cues, promoting physiological stability and self-calming behaviours • Protect baby's sleep and ability to self-regulate • Avoid pain, distress and iatrogenic injury • Protect developing musculoskeletal systems by promoting midline postures and symmetry • Increase parents' confidence and competence	• Closely observe baby's physiological, motor and behavioural cues. Plan, adapt and pace care-giving and interventions in response • Have all necessary equipment ready before starting • Approach baby carefully, using soft voice and gentle touch, allowing time to adjust before beginning • Keep lighting and noise levels low • Support and comfort baby throughout: ◦ administer appropriate analgesia including sucrose and MEBM ◦ avoid totally exposing baby ◦ facilitate baby's self-calming strategies according to behavioural cues e.g. non-nutritive sucking, grasping, hand-to-mouth and foot bracing ◦ use swaddling and containment (hands/nest/soft blanket or clothing) to provide support during care or procedure ◦ allow baby 'time-out' to recover if cues indicate stress. Recommence when baby is calm • Use side-lying position for cares, including nappy changes. Promote a flexed position with limbs tucked in. Do not lift baby's legs, place soles of feet together and roll side-to-side instead • Use containment and swaddling for transfers into/out of incubator/cot, weighing, and bathing. Move baby slowly, in flexed, side-lying position, close to carer's body • Promote positive touch and active parental role • Promote kangaroo care as soon as possible (see **Kangaroo care** guideline) • Ensure baby settled, comfortable and stable before leaving bedside

DEVELOPMENTAL DYSPLASIA OF THE HIP (DDH) ● 1/3

INTRODUCTION

- DDH ranges from mild acetabular dysplasia with a stable hip through more severe forms of dysplasia, often associated with neonatal hip instability, to established hip dysplasia with/without later subluxation or dislocation
- Delayed diagnosis requires more complex treatment and has a less successful outcome than dysplasia diagnosed early
- Screening for DDH is part of the newborn and infant physical examination (NIPE)

MORE COMMON IN BABIES WITH:

- Family history of first degree relative with DDH
- Breech presentation during pregnancy
- Hip abnormality on clinical examination
- Structural foot abnormality – congenital calcaneovalgus, fixed talipes equinovarus
- Significant intrauterine moulding – congenital torticollis, congenital plagiocephaly
- Birth weight >5 kg
- Oligohydramnios
- Multiple pregnancy
- Prematurity
- Neuromuscular disorders

SCREENING FOR DDH

- All babies are offered a NIPE to be completed by aged 72 hr, to include:
- questions to the parents to identify risk factors for DDH and a thorough examination for hip abnormalities
  - ask parents: “Is there anyone in the baby’s close family, i.e. mother, father, brother or sister, who has had a hip problem that started when they were a baby or young child and that needed treatment with a splint, harness or operation?”
- Ortolani and Barlow tests, to detect an unstable hip, or hip that is dislocated or sublaxated but reducible
  - will not detect an irreducible hip, which is best detected by identifying limited abduction of the flexed hip

HIP EXAMINATION

Observe for

- Symmetry of leg length
- Level of knees when hips and knees are both flexed with feet together

Manipulation

- Barlow test and Ortolani test (see **Figure 1**)
- When examining hip, stabilise pelvis on opposite side
- Can legs be fully abducted

Barlow test

- Hip adducted and flexed to 90°
- Hold distal thigh and push posteriorly on hip joint
- Test is positive when the femoral head felt to slide posteriorly as it dislocates

Ortolani test

- Stabilise pelvis and examine each hip separately
- In a baby with limited hip abduction in flexion, hip is flexed to 90° and gently abducted while examiner’s finger lifts the greater trochanter
- Test is positive when the femoral head is felt to locate into the acetabulum

Figure 1

Contains public sector information licensed under the Open Government Licence v3.0
https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

REFERRAL FOR ENHANCED SCREENING

- Enhanced screening is done through ultrasound of the hips
- NIPE guidelines include specific criteria for referral for enhanced screening and the timescale in which this should occur
- Individual trusts may add local criteria to supplement national criteria
- **SCREEN POSITIVE** result is an abnormal clinical hip examination (with/without risk factors) or NIPE hip risk factors

Abnormal examination defined as:

- Difference in leg length
- Knees at different levels when hips and knees bilaterally flexed
- Difficulty abducting hip to 90°
- Palpable 'clunk' when undertaking Ortolani or Barlow manoeuvre

NIPE hip risk factors:

- Family history of first degree relative with hip problems in early life, unless DDH has definitely been excluded
- Breech presentation at ≥36 completed weeks of pregnancy, irrespective of presentation at delivery or mode of delivery, **or**
- Breech presentation at the time of birth between 28 weeks' gestation and term
- In the case of a multiple birth, if any baby falls into either category, all babies in this pregnancy to have ultrasound examination

Additional local criteria for referral may include:

- Significant moulding
- Congenital torticollis, congenital plagiocephaly
- Structural foot deformity
- Congenital foot deformity, especially fixed talipes calcaneovalgus or equinovarus
- Check your local referral criteria

PROCESS

Screen negative − no risk factors on history and normal examination

- No further intervention needed
- Inform parents and document findings
- These babies will be rechecked at their 6–8 week check

Screen positive – (risk factors or abnormal examination as detailed above)

- Inform parents of findings and plan for further investigation
- Document findings and plan
- Request outpatient hip ultrasound to be performed in accordance with NIPE guidance
- For babies born <34^{+0} weeks' gestation, hip ultrasound should be undertaken 38−40 weeks' corrected age
- For babies born ≥34^{+0}, hip ultrasound scan should be undertaken at aged 4−6 weeks
- Departments to have system in place to review all hip scan results and inform parents as they are reported
- babies with normal hip scan require no further action and will be re-examined at their 6–8 week check
- babies with abnormal hip scan require a specialist assessment

- An outcome decision for all babies should have been made by aged 6 weeks for babies born ≥34^{+0}, and by 40^{+0} weeks' corrected age for babies born <34^{+0} weeks

Dislocated/dislocatable/unstable hip – positive Ortolani or Barlow test or limited hip abduction

- Review by tier 2 staff/consultant to confirm diagnosis
- Inform parents of findings and plan for further investigation and management
- Document findings and plan
- Urgent referral required
- Check local policy regarding referral to physiotherapy/orthopaedic team and ultrasound. Service may be provided locally or referral to a tertiary centre paediatric orthopaedic team may be required

DEVELOPMENTAL FOLLOW-UP OF CHILDREN BORN PRETERM ● 1/2

Based on NICE guideline NG72 Developmental follow-up of children and young people born preterm

INDICATIONS

- Gestation <30 weeks
- Grade 3 or 4 IVH, cystic PVL or other brain lesion likely to be associated with developmental disorders
- Grade 2 or 3 HIE
- Neonatal bacterial meningitis
- Neonatal herpes simplex infection
- Any other locally agreed criteria

IDENTIFICATION OF ELIGIBLE BABIES

- Responsibility of everyone admitting babies to use the correct coding to facilitate appropriate follow-up pathway
- Initial unit of booking is responsible for performing assessment
- NNU discharging baby to document unit responsible for follow-up in **BadgerNet** discharge summary
- NNU to use **BadgerNet** to confirm which babies are their responsibility for assessment.
- if baby listed incorrectly contact follow-up lead in appropriate unit to ensure baby is seen by appropriate neonatal/community service

ASSESSMENTS

Timings

- Minimum of 2 face-to-face meetings that focus on development at corrected age of 3–5 months **and** by 12 months
- Detailed face-to-face assessment at aged 2 yr (corrected age) see below

Checks at each developmental visit

- Discuss any parental concerns regarding development
- Measure length, weight and head circumference
- Multidisciplinary review (see below) to check for signs and symptoms of developmental problems e.g.
- cerebral palsy
- global developmental delay and learning disability
- autism spectrum disorder
- visual impairment
- hearing impairment
- feeding problems
- sleep problems, including sleep apnoea
- speech, language and communication problems
- motor problems
- problems with inattention, impulsivity or hyperactivity
- emotional and behavioural problems
- executive function problems
- potential special educational needs
- Possible early signs of cerebral palsy include:
- delayed motor milestones, e.g. late sitting, crawling or walking
- unusual (abnormal or absent) fidgety movements or other abnormalities of movement including asymmetry or paucity of movement
- abnormalities of tone including hypo- or hypertonia
- persisting feeding difficulties
- If problem suspected, refer child as per local pathway
- ensure child continues to be seen within developmental follow-up pathway

Assessment at 2 yr (corrected age)

- As a minimum, NICE advises all aspects listed above plus:
- use Parent Report of Children's Abilities – Revised (PARCA-R) to identify if child is at risk of global developmental delay, learning disability or language problem
- use Gross Motor Function Classification System (GMFCS) if cerebral palsy has been diagnosed
- ensure vision and hearing checks have been carried out in line with national recommendations
- National Neonatal Audit Programme (NNAP) analysis includes whether standardised assessment (Schedule of Growing, Bayley III or Griffiths) has been performed
- If Bayley III/IV assessment is used:

- send parental questionnaire before assessment and request parents complete and bring to assessment
- send copy of assessment outcome summary to GP, health visitor and parents. Complete 2 yr follow-up form in **BadgerNet**
- Children born ≥28 weeks:
- if development is normal and no physical health issues, discharge
- if continuing physical health problems, follow-up with general paediatrician or appropriate specialist
- if neurodevelopmental problems identified, refer to relevant allied health professionals and community paediatrician

Assessment at 4 yr (uncorrected age)

- Indicated for children born <28 weeks' gestation
- To include educational/clinical psychologist and paediatrician with expertise in neurodevelopment
- As a minimum, NICE recommends all the checks listed for every visit plus:
- request parents complete Strengths and Difficulties Questionnaire (SDQ) and Ages and Stages Questionnaire (ASQ) 48-month questionnaire in advance and discuss results at appointment
- review previous assessments and information from all other relevant sources
- use standardised test to assess IQ e.g. Wechsler Preschool and Primary Scales of Intelligence (WPPSI)
- GMFCS score if cerebral palsy diagnosed
- ensure child has been offered orthoptic vision screening
- Provide a comprehensive summary, including a plan for any necessary intervention and support, in a format accessible to parents

Multidisciplinary team (MDT)

- MDT delivering enhanced developmental support and surveillance for children born preterm to include the following professionals:
- neonatologist/paediatrician with understanding of neonatal care and child development
- outreach nurse/nurse with expertise in development of babies born preterm
- ≥1 of:
  - occupational therapist
  - physiotherapist
  - speech and language therapist
- In addition to the above, have access to:
- paediatric neurologist
- dietitian

RESOURCES

- Guideline summarised as flowchart – see **Supporting information**
- https://www.nice.org.uk/guidance/ng72
- https://www.nice.org.uk/guidance/qs169

DISCHARGE FROM NEONATAL UNIT ● 1/2

DECISION TO DISCHARGE

- Only consultant or tier 2 staff decide readiness for discharge
- Medical and nursing staff to agree discharge date with parents or persons with parental responsibility
- Nursing team/allocated discharge planner perform majority of discharge requirements

DISCHARGE CHECKLIST

Where appropriate, the following must be achieved before discharge:

Parental competencies

- Administration of any medications when required
- give parents information on how to get repeat prescriptions and expected duration of medications/prescription formula
- Baby care (e.g. nappy changes, top and tailing, bathing etc.)
- Feeding (including how to make up formula if appropriate)
- Nasogastric tube feeding where necessary
- Stoma care
- Home oxygen where necessary

Parent education

- In addition to above, it is best practice to offer parents education on:
- basic neonatal resuscitation (practical demonstration or leaflet/DVD etc.)
- common infectious illnesses (see https://www.bliss.org.uk/parents/about-your-baby/common-infectious-illnesses)
- immunisations, if not already received (give national leaflet)
- safer sleeping

Parent communication

- Check home and discharge addresses and confirm GP details with parents
- Complete Red Book (include immunisations given and dates) and give to parents
- Give parents copy of discharge summary and time to ask questions after they have read it
- Follow local policy for breast pump loan and/or return
- Ensure parents have information regarding local breastfeeding groups for ongoing support, and BLISS support group meeting
- Ensure parents have up-to-date information on sleeping position, car seats and avoidance of co-sleeping
- If transporting in a car, use suitable car seat
- If transferring to another unit, ensure parents understand reason for transfer. Provide information about receiving unit
- Ensure remaining mother's breast milk in hospital fridge/freezer given to take home

Parent information

Local unit discharge pack

Procedures/investigations

- Newborn bloodspot (see **Bloodspot screening** guideline)
- for babies <32 weeks' gestation, repeat on day 28 or day of discharge if sooner
- When immunisation (2, 3 and 4 month) not complete in preterm babies, inform GP and health visitor
- Give (or arrange) BCG immunisation if required
- BCG (see **BCG immunisation** guideline) and/or hepatitis B (see **Hepatitis B and C guideline**)
- Complete audiology screening (see **Hearing screening** guideline)
- Where required, confirm ophthalmology appointment date [see **Retinopathy of prematurity (ROP) screening** guideline]
- If going home on oxygen, follow **Oxygen on discharge** guideline
- Ensure cranial ultrasound scans completed (if indicated) or arrange out-patient appointment scan
- Arrange outpatient hip ultrasound scan, if indicated

Professional communication

- Complete admission book entries
- Inform:
- health visitor of discharge
- community midwife if baby aged <10 days
- if safeguarding concerns, notify community midwife and social worker

- GP
- community neonatal or paediatric team as required locally

Multidisciplinary (MDT) review/discharge planning meeting

- Babies with safeguarding concerns (to formulate child protection plan)
- Babies with complex needs (e.g. home oxygen therapy or nasogastric tube feeding)
- Babies with antenatal palliative care plans require MDT (obstetrics, neonatal and community paediatrics/palliative care) meeting/discharge planning before and soon after delivery, considering parental wishes towards palliative care following birth
- Other babies as appropriate

Medical team

- Complete discharge summary by date of discharge
- Complete **BadgerNet** dataset by date of discharge (complete 'final neonatal outcome')
- Answer parents' questions after they have read discharge summary
- Ensure all follow-up appointments made (see **Follow-up**)
- Perform and record discharge examination

FOLLOW-UP

Appointments

- Parents to have single point of contact following discharge
- Ensure appointments are written on discharge summary and in Red Book. Likely appointments could include:
- neonatal/paediatric consultant outpatient clinic
- ophthalmology screening
- audiology referral
- cranial ultrasound
- MRI scan
- physiotherapy
- hip or renal ultrasound
- dietitian
- community paediatrician
- child development centre
- palivizumab
- planned future admission (e.g. for immunisations)
- planned future review for blood taking, wound review
- tertiary consultant outpatients
- Open access to children's wards where available and appropriate
- See also **Follow-up of babies discharged from the neonatal unit** guideline

DISORDERS OF SEXUAL DEVELOPMENT ● 1/2

RECOGNITION AND ASSESSMENT

Definition

- New nomenclature: disorders of sexual development (DSD) known formerly as ambiguous genitalia
- Congenital conditions in which development of chromosomal, gonadal or anatomical sex is atypical, most commonly:
  - congenital adrenal hyperplasia
  - gonadal dysgenesis
  - partial androgen insensitivity
- For DSD classification, see **Supporting information**

Factors suggesting DSD

- Overt genital ambiguity (e.g. cloacal exstrophy)
- Apparent female genitalia with enlarged clitoris, posterior labial fusion or inguinal/labial masses
- Apparent male genitalia with bilateral undescended testes, isolated perineal hypospadias, micropenis (normal penis ≥1.9 cm), or mild hypospadias with undescended testis
- Family history of DSD e.g. complete androgen insensitivity syndrome (CAIS)
- Discordance between genital appearance and antenatal karyotype
- Pseudo-ambiguity (atrophic vulva and clitoral oedema) in growth-restricted or preterm female babies

PRINCIPLES OF MANAGEMENT

This is a medical emergency; involve consultant immediately

- **Avoid gender assignment before expert evaluation**
- Consultant to discuss with parents
  - always use the term ‘baby’ and avoid using ‘he’, ‘she’ or, most importantly, ‘it’
  - advise parents about delaying registration and informing wider family and friends until gender assignment complete
  - liaise with laboratory to enable evaluation without indicating gender in laboratory request forms
- Link with expert centre for appropriate evaluation
- Communicate openly with family
- Respect family concerns and culture
- DSD is not shameful
  - best course of action may not be clear initially
  - parents need time to understand sexual development

First line investigations

- Blood pressure
- Karyotype of QF-PCR (urgent)
- Imaging
  - abdominal and pelvic ultrasound by an experienced paediatric sonographer
  - assess presence and nature of internal genitalia, including gonads
- Blood tests
  - cortisol short synacthen test
  - 17-OHP (delay until day 3 to allow maternal hormonal effects to decline)
  - testosterone and oestradiol
  - LH, FSH
  - U&E and glucose

Further investigations (following discussion with specialist endocrine advice)

- dHT (dihydrotestosterone)
- DHEA (dihydroepiandrosterone)
- Androstenedione
- ACTH
- LHRH and hCG stimulation
- ACTH stimulation test
- AMH (anti-mullerian hormone) imaging studies
- Molecular genetic studies [e.g. for complete androgen insensitivity syndrome (CAIS)]
- Urine: steroid profile
- Biopsy of gonad

DISORDERS OF SEXUAL DEVELOPMENT ● 2/2

TREATMENT

- Avoid unnecessary admission to NNU
- Check serum electrolytes and plasma glucose
  - in congenital adrenal hyperplasia electrolytes usually not abnormal until day 4
- Involves a multidisciplinary team with an identified person (usually consultant neonatologist) acting as primary contact with family
- Specific treatment dependent on many factors and diagnosis
  - discuss with specialists

DOWN SYNDROME – INITIAL MANAGEMENT ● 1/4

INTRODUCTION

- Congenital disorder arising from a chromosome defect
- Majority due to trisomy of chromosome 21
  - 4% translocations
  - 1% mosaics
- Antenatal screening and subsequent termination of pregnancies results in incidence at birth of 0.8/1000
- Incidence increases with increasing age of mother from 1:1500 at aged 20 yr to 1:100 aged 40 yr

DIAGNOSIS

Antenatal

- Confirm cases identified through antenatal screening/high-risk women by amniocentesis/chorionic villi sampling
- Arrange for parents to be seen by neonatal/paediatric consultant
- Complete local paediatric alert for postnatal care
- Give parents opportunity to visit NNU
  - if visits not possible direct parents to virtual tour (if available)

Postnatal

- Approximately 30% of cases are not identified before birth – mainly due to screening declined/not undertaken
- If suspected on newborn and infant physical examination (NIPE), request immediate detailed clinical examination by paediatrician/advanced neonatal nurse practitioner
- Identify any urgent medical needs (e.g. feeding, cardiac or respiratory problems)
- Consultant paediatrician/neonatologist to discuss testing with parents
- Send EDTA blood sample to regional genetic laboratory for confirmation by testing QF-PCR and lithium heparin sample for karyotyping

Parent consultation

- Parents may have conflicting emotions
- Parents to be seen by consultant:
  - antenatally diagnosed: ≤24 hr of birth
  - postnatally diagnosed: ≤24 hr of suspicion
  - use interpreter for non-English speaking parents
  - if possible/appropriate both parents to be present during consultation
  - deliver explanation of baby's features and diagnosis sensitively
  - give parents time to absorb information
- Repeat visits may be necessary to deal with questions and distress
- If possible, same consultant to continue to see baby and parents until discharge
  - if not possible, named/follow-up consultant must have clear handover

INITIAL MANAGEMENT

Age	Professional	Tasks
Birth	Consultant paediatrician/ neonatologist	• Neonatal examination • QF-PCR genetic testing +/- karyotyping to confirm Down syndrome • Blood for chromosomes, FBC and manual blood film for peripheral blasts ◦ if blasts present and/or clinical signs suggestive of (transient leukaemia of Down syndrome) TL-DS, discuss with paediatric haematologist and send peripheral blood sample for GATA1 mutation analysis • Counselling of parents by consultant (see **Parent consultation**) • Give written information to parents (e.g. Down's Syndrome Association pack with new parent leaflet – available from http://www.downs-syndrome.org.uk/for-new-parents/new-parent-pack/) • Notify midwife, obstetrician, GP, and health visitor • Cardiac assessment including: ◦ pre and postductal pulse oximetry ◦ ECG (if available locally) – discuss with consultant ◦ if cardiac symptoms/signs or abnormal ECG, detailed clinical cardiac examination including echocardiogram within 2 weeks ◦ if no cardiac symptoms and normal ECG, cardiac review and echocardiogram within 4–6 weeks • Gastrointestinal atresia – observe for vomiting (bile stained) • Hirschsprung's disease – ensure meconium passed ≤24 hr of birth • Visual assessment: ◦ check visual behaviour and red reflexes for congenital cataract and nystagmus ◦ if concerns refer to ophthalmologist • Follow-up with a paediatrician/neonatologist • Refer to community paediatric team with detailed summary and copies of all other referrals (e.g. ophthalmology, cardiology) • Discuss referral to early support services • Nurse specialist/dietician to provide feeding advice • Speech and language assessment/therapy referral where necessary • Provide parents with information and/or additional sources of help and advice • Replace growth charts in Personal Child Health Record (PCHR) and notes with specific Down syndrome insert/chart and plot growth parameters • Check automatic referral to audiology has been made
≤5 days	Midwife	• Risk of congenital hypothyroidism – ensure heel prick test performed
2–4 weeks	Consultant paediatrician	**Follow-up appointment** • Review parental concerns and medical history, particularly cardiac symptoms, feeding and bowel habit • Ensure Down syndrome insert in PCHR and growth parameters plotted on Down syndrome growth chart • Cardiac examination ◦ check seen in cardiology clinic • Examine eyes for cataract and nystagmus • Verify results of TSH screen • Check referral to child development centre • If concerns, refer to dietician and community speech and language therapy (SALT)

6 weeks	Health visitor/GP	**Routine Child Health Service – primary birth visit** • Plot growth on Down syndrome chart • Issue Down syndrome specific pages and growth chart for PCHR if not already issued • Recheck for red reflex and other eye anomalies
8 weeks	Health visitor/GP	• Primary immunisations
3–4 months	Paediatrician/ community paediatrician/child development centre	**Initial assessment** • Developmental assessment • Refer to physiotherapy as appropriate • Ensure referred to ophthalmologist and SALT • Review newborn hearing screening programme results (in PCHR) • Hearing screening ◦ if no clear bilateral or unilateral response: refer for audiological assessment ◦ if bilateral clear response: ensure referral for targeted follow-up aged 6–10 months • Refer to early support services • TSH, FT4 and thyroid antibodies at aged 4–6 months, then aged 12 months and annually thereafter, unless: ◦ already receiving treatment for thyroid disorder **or** ◦ develops signs and symptoms of thyroid dysfunction – earlier testing indicated

- Complete neonatal checklist for management of babies with Down syndrome (if available locally)

LATER REVIEWS

- At all stages review/discuss:
  - parental concern
  - developmental progress
  - growth using specific Down syndrome chart
  - hearing and visual problems
- Formal ophthalmological assessment aged 18 months–2 yr, then aged 4 yr
  - more often if abnormal
- Formal audiology assessment aged 6–10 months then
  - 6-monthly until aged 2 yr then
  - annually aged ≤18 yr
  - more often if abnormal
- Copy clinic letters to parents and all professionals involved

Age	Review/action
9 months	• Follow surveillance check list, if available locally • Exclude squint • Audiology assessment • Developmental progress
12 months	• TSH, FT4 and thyroid antibodies, then annually ◦ if TSH levels elevated/positive antibodies present, discuss with endocrine team
18 months	• Developmental progress review ◦ discuss schools/nurseries as appropriate • Monitor growth and plot on Down syndrome chart every visit • Check dental health and refer to specialist community paediatric dentist • Check gastrointestinal symptoms – constipation/diarrhoea, increased risk of coeliac disease • If symptoms of obstructive sleep apnoea present refer to ENT team • Assess gait, bowel and bladder function ◦ risk of atlanto-axial subluxation – suspect if new symptoms of gait disturbance, abnormal neck posture and/or deterioration in bladder/bowel function

	• Increased incidences of: ◦ type 1 diabetes (10 x normal) ◦ autism ◦ leukaemia • Advise parents about relevant benefits e.g. disability living allowance (DLA) ◦ DLA has 2 parts – care and mobility – all children with Down syndrome will eventually receive DLA – advise parents to consider application when child requires more help than children of a similar age (local authorities have denied applications on the basis that a baby with Down syndrome has the same needs as any other baby) – application for mobility element of DLA can only be made when child aged ≥3 yr • Give information about local and national Down syndrome support groups

FURTHER USEFUL INFORMATION

- Down's Syndrome Association: www.downs-syndrome.org.uk
- Down Syndrome Medical Interest Group: www.dsmig.org.uk

DROPPED BABY ● 1/3

Based on BAPM document: **The Prevention, Assessment and Management of In-Hospital Newborn Falls and Drops pu**blished March 2020 (https://www.bapm.org/resources/161-the-prevention-assessment-and-management-of-in-hospital-newborn-falls-and-drops#:~:text=of%20Perinatal%20Medicine)

RISK FACTORS

- Co-bedding/co-sleeping whilst breastfeeding
- Impaired awareness of mother e.g. fatigue, sedation, mobile phone use, dim lighting
- Immobility of mother e.g. epidural
- Primiparous mother
- Underlying maternal condition e.g. epilepsy, diabetes, disability, raised BMI
- Social issues e.g. young mother, single mother, language barrier
- Time of day

ASSESSMENT – IMMEDIATE ACTIONS

- Place baby on warm, well-lit surface – ideally resuscitaire
- Assess:
  - airway, breathing, circulation
  - level of consciousness, and pupil size and reaction to light
  - local traumatic injuries
  - full neurological examination and enhanced observations

Immediate assessment and actions

Assessment	Action
Any of following: • Unresponsive • Abnormal movement/posturing/seizure • Floppy/not moving • Only opens 1 eye with/without new bruising/swelling • Asymmetrical pupils • New external injury	• Call neonatal crash team • Assess and stabilisation as per NLS algorithm • Admit to NNU for investigation and assessment

All of following:
• Alert and moving normally
• Sleepy, but wakes on handling
• Poor feeding/not interested
• Irritable but consolable
• Eyes equally open
• Pupils equal and reactive
	• Paediatric team to review within 15 min
	• Can remain on PN ward/transitional care unit
	• Start enhanced observations*
	  • continue for 12 hr
	  • if observations change, for immediate paediatric review

*Enhanced observations = newborn early warning track and trigger (NEWTT2) or neonatal early warning score (NEWS) if NEWTT2 not yet implemented + modified paediatric Glasgow coma scale (GCS)

ASSESSMENT – BY PAEDIATRIC TIER 2 STAFF

History

- Details of fall
  - time
  - detailed description of events
  - estimated height of fall (significant injury can occur after fall from a low height)
  - witnesses
- Most falls are accidental but be alert to possibility of non-accidental injury. Note:
  - consistency of history
  - consistency between injury and proposed mechanism of injury
  - other injuries
  - wider social situation (including safeguarding risks)
- Mode of delivery and any injuries attributed to birth
- Administration of vitamin K – if not given or given orally, give IM (for dose see **Vitamin K** guideline)

Examination

- Full medical and neurological examination checking for signs of injury
- Use body map to document any bruises, redness, swelling or skin marks

- Perform neurological examination, and enhanced observations [NEWTT2 (or NEWS if NEWTT2 not yet implemented) + modified GCS]
- Check https://hubble-live-assets.s3.amazonaws.com/bapm/attachment/file/244/Baby_Falls_-_FINAL_VERSION_19-03-20.pdf
  - anterior fontanelle and sutures
  - pupil size, symmetry and response to light
  - tone and power
  - primitive reflexes
- Measure occipital frontal circumference and plot
- Review the need for analgesia (see **Pain assessment and management** guideline)

MONITOR

- NEWTT2 (or NEWS if NEWTT2 not yet implemented) and modified GCS for ≥12 hr
  - half hourly for 2 hr
  - hourly for 4 hr
  - 2-hrly for 6 hr
- NEWS:
  - heart rate
  - respiratory rate
  - SpO_2
  - temperature
- Modified GCS
  - eye opening
  - pupil reaction and size
  - best vocal response or grimace to stimulus
  - best motor response to stimulus
  - limb movement and tone
- If all observations normal and no indications for CT head scan: discontinue after 12 hr
- If any observations abnormal: request immediate tier 2 staff review
  - baby may require return to half hourly observations or NNU admission and investigations

INVESTIGATIONS

Babies on postnatal ward/transitional care unit with stable enhanced observations

- No further investigations needed

Babies admitted to NNU for clinical concerns

- FBC, U&E, group and save, clotting, blood gas, blood glucose
- If intracranial bleeds/fracture suspected, urgent CT head scan (see below)

Urgent CT head scan

- If indicated to be performed and reported within 1 hr of injury after stabilisation
- Do not delay CT by performing cranial ultrasound scan, as this has poor sensitivity for detecting extra-axial fluid collections
- If any of the following risk factors perform CT scan:
  - seizure
  - focal neurological deficit including:
    - asymmetrical pupils
    - ptosis
    - unilateral weakness
    - posturing
  - loss of consciousness or unresponsive episodes
  - modified GCS <14 on first assessment
  - any soft tissue injury (bruise, swelling, laceration) not present before fall
  - suspicion of non-accidental injury
  - suspected open/depressed skull fracture
  - any sign of basal skull fracture
    - haemotympanum
    - 'panda' eyes
    - cerebrospinal fluid leakage from ear or nose
    - Battle's sign (bruising over mastoid process)

- If ≥2 of the following risk factors, urgent review, and consideration of need for CT
- ≥3 episodes of forceful/projectile vomiting in 1 hr
- abnormal drowsiness or irritability lasting >5 min
- fall from height ≥90 cm
- If concerns of spinal injury, MRI head and spine after discussion with paediatric neurosurgical team

DOCUMENTATION/COMMUNICATION

- Complete incident form
- Consider possibility of non-accidental injury and document outcome of this
- Ensure communication with mother includes provision of emotional support and information regarding immediate management plan
- Inform consultant

SUBSEQUENT MANAGEMENT FOR BABY REQUIRING CT SCAN

- If CT abnormal discuss with neurosurgical centre
  If CT normal/not indicated continue to monitor baby as described above for ≥12 hr
- If enhanced observations become abnormal admit to NNU and investigate as detailed above
- Baby with normal CT scan and no other clinical concerns may be monitored on postnatal ward or transitional care (if staff are competent to perform enhanced observations)

DISCHARGE

- If observations normal for 12 hr and no significant extracranial injuries/concerns about safeguarding, then tier 2 staff/consultant may discharge baby
- Ensure community midwife/health visitor aware of discharge and that the fall, assessment and investigations documented in discharge summary
- If CT scan abnormal, follow-up as advised by neurosurgical team

ECG ABNORMALITIES • 1/4

INTRODUCTION

- 1–5% of normal newborn babies have irregularities in heart rhythm within the first 10 days of life. These are largely self-limiting and benign
- Need to distinguish between:
- normal sinus arrhythmia (including pauses up to 1.5 sec)
- benign arrhythmias (including premature atrial and premature ventricular contractions)
- pathological arrhythmias [can be divided into tachyarrhythmias (SVT and VT) and bradyarrhythmias (congenital heart block and congenital long QT syndrome)]
  - pathological arrhythmias are more common in babies with congenital heart disease (especially post-operatively)

PREMATURE ATRIAL BEAT

Recognition and assessment

- Most common form of arrhythmia
- In a regular sinus rhythm at a normal rate, a P wave occurring before next expected P wave is a premature atrial beat
- Usually has a different morphology (P wave different in shape and size from normal P wave)
- Most premature atrial beats are benign

Management

- 12-lead ECG – ensure rate, rhythm and QTc are calculated
- Check electrolytes (particularly for potassium)
- Check position of tip of central venous catheter (if present)
- Follow-up ECG aged 1 month (small risk of SVT)
- If premature atrial contractions persist, seek cardiology advice

PREMATURE VENTRICULAR BEAT

Recognition and assessment

- Premature abnormal QRS complex not preceded by premature P wave

Investigations

- 12-lead ECG – ensure rate, rhythm and QTc are calculated
- Check electrolytes (particularly for potassium)
- Check position of tip of central venous catheter (if present)
- Echocardiogram to rule out structural abnormality of heart

Immediate treatment

- Seek advice from paediatric cardiologist

SINUS TACHYCARDIA

Recognition and assessment

- Sinus rhythm (P wave precedes every QRS complex) with a heart rate above normal limit for age and gestation

Causes

- Fever
- Infection
- Low haemoglobin
- Pain
- Prematurity
- Hypovolaemia
- Hyperthyroidism
- Myocarditis
- Drugs (e.g. caffeine and salbutamol)

Management

- Treat the cause
- If myocarditis suspected – echocardiogram

SINUS BRADYCARDIA

Recognition and assessment
- Sinus rhythm (P wave precedes every QRS complex) with a heart rate below normal limit for age and gestation
- Calculate QT interval to rule out congenital long QT syndrome and signs of heart block
- in first 7–10 days of life, QT interval can be transiently prolonged – initial ECG not to be used in isolation to diagnose congenital long QT syndrome)

Differential diagnosis
- Hypoxia (most likely cause)
- Vagal stimulation
- Post-intubation
- Hypovolaemia
- Hypothermia
- Metabolic derangement
- Hypopituitarism
- Obstructive jaundice
- Drugs passed from mother to baby (labetalol)
- Maternal SLE

Immediate management
- Manage airway and breathing
- If intubation required, optimise ETT position
- If bradycardia occurs post-intubation, use atropine (see **Neonatal Formulary**)
- Correct hypovolaemia
- Correct metabolic derangement
- If persistent, obtain 12-lead ECG
- Evaluate and treat underlying cause

SUPRAVENTRICULAR TACHYCARDIA

Recognition and assessment
- Rapid regular tachyarrhythmia
- Heart rate >220 bpm
- ECG:
- P waves commonly absent. When present they almost always have an abnormal morphology
- narrow QRS complex
- in fast sinus tachycardia, P waves can be very difficult to see
- look for delta waves consistent with Wolff-Parkinson-White syndrome as this can affect the choice of anti-arrhythmic agent used
- For further information see **Supraventricular tachycardia** guideline

VENTRICULAR TACHYCARDIA

Recognition and assessment
- Heart rate >200 bpm
- Wide QRS complexes
- ≥3 repetitive complexes

Immediate management
- Manage airway and breathing
- Correct hypoxia
- Correct electrolyte disturbance
- Discuss with paediatric cardiologist
- Consider synchronised cardioversion (in very fast heart rates, defibrillators cannot synchronise with the patient and unsynchronised will be required) if intubated, with analgesia
- Amiodarone 5 mg/kg over 30 min IV (repeat if necessary)
- If no response, lidocaine 0.5–1 mg/kg IV. May be repeated after 5 min. Maximum cumulative dose 3 mg/kg

TACHYARRHYTHMIA

- True heart rate?

ECG ABNORMALITIES ● 3/4

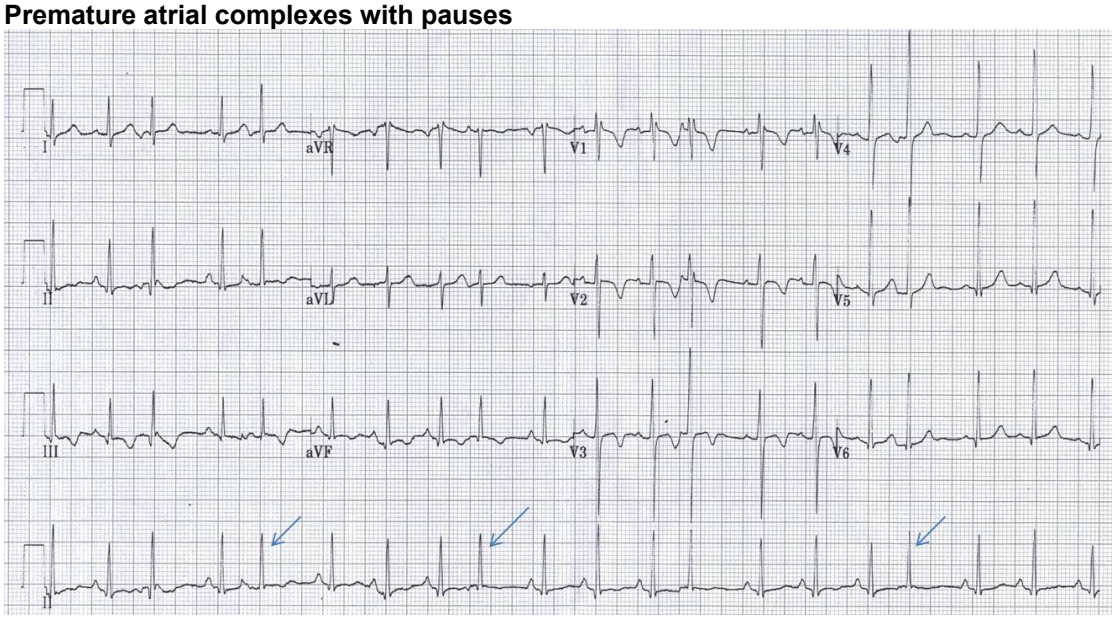
- Is baby crying/in pain?
- Check airway and breathing
- Check saturation
- Consider arterial/capillary gas
- Check perfusion
- Check blood pressure
- Manage airway and breathing
- Correct hypoxia
- Correct electrolyte disturbance

12-lead ECG

- Narrow QRS complex
- Majority SVT
- Absent/abnormal P wave
  - vagal manoeuvres
  - adenosine
  - discuss with paediatric cardiologist
  - consider synchronised cardioversion

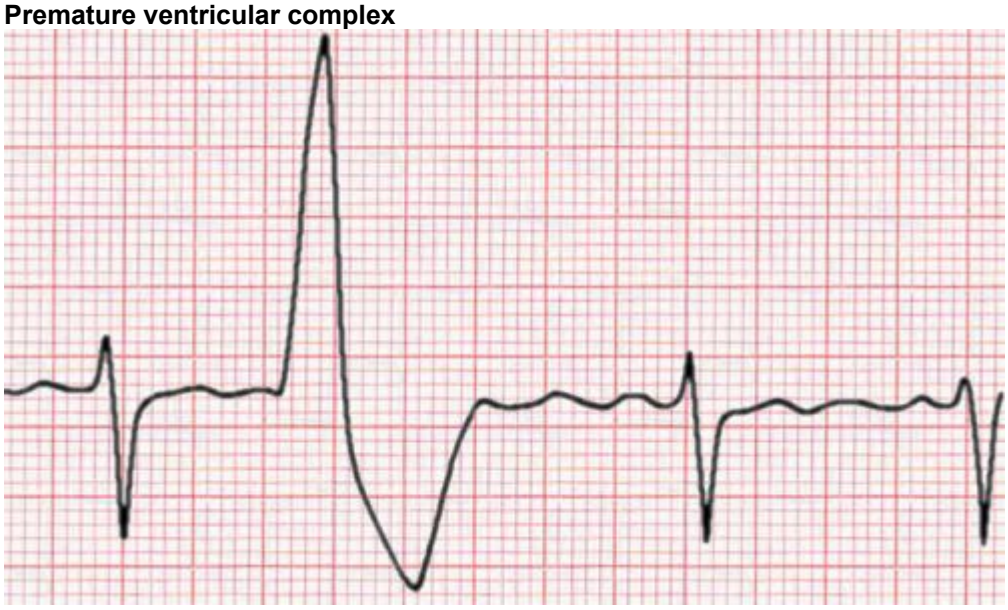
- Broad QRS complex
- Abnormal P wave
  - discuss with paediatric cardiologist
  - synchronised cardioversion

Premature atrial complexes with pauses

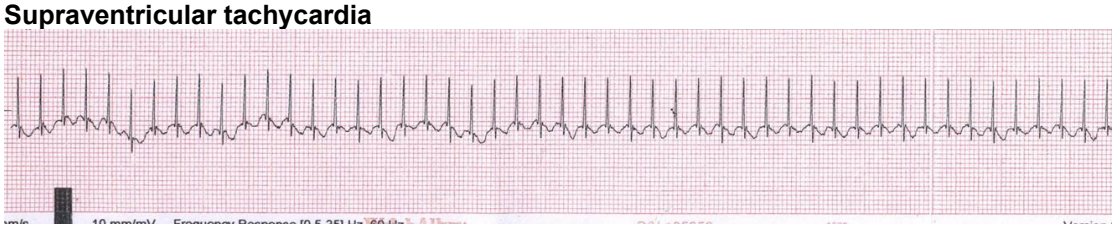


ECG ABNORMALITIES ● 4/4

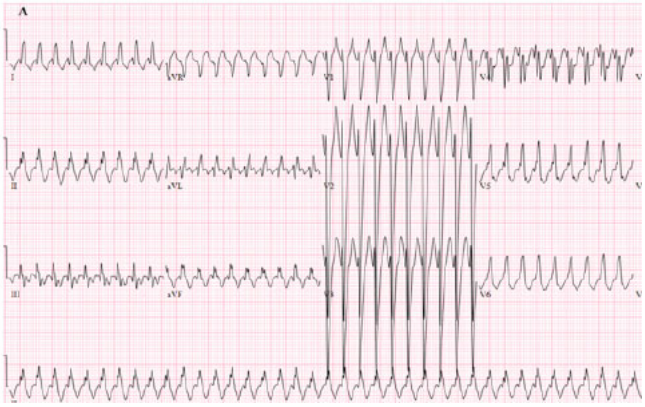
Premature ventricular complex



Supraventricular tachycardia



Broad complex tachycardia



ENDOTRACHEAL TUBE (ETT) SUCTIONING ● 1/3

INTRODUCTION

- This guideline:
  - relates only to a closed suction catheter system in ventilated babies, which is non-aerosol generating
  - describes a standard safe approach, but it may be necessary for an adapted method to be employed (see **If ETT clearance proves difficult with standard approach**)
- Goal of ETT suctioning should be to maximise the amount of secretions removed with minimal adverse effects
- Should not be a routine procedure, but in response to indications

INDICATIONS

- To maintain airway patency
- To remove respiratory secretions or aspirated fluid from within the ETT
- To optimise oxygenation and ventilation in an intubated baby
- To obtain secretions for culture analysis

EQUIPMENT

- In line/closed circuit catheter
  - catheter size <0.5 diameter of ETT
- PPE as per local guidelines for non-aerosol generating procedures
- Sodium chloride 0.9%
- 1 mL syringe

PROCEDURE

- **Do not** attempt to carry out this procedure unless trained in the use of endotracheal closed suction catheter system

Preparation

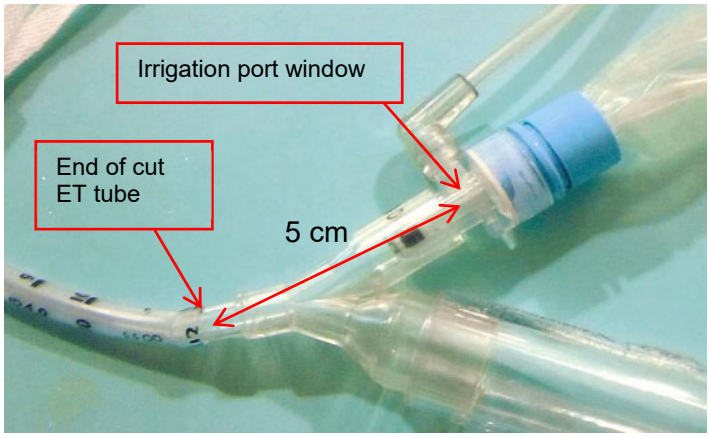
- Wash hands and put on PPE
- Auscultate chest before suctioning
- Ensure full monitoring of heart rate and SpO_2 in place
- Ensure baby is adequately oxygenated; consider increasing FiO_2 by up to 0.1 before procedure, e.g. if baby receiving FiO_2 of 0.3 (or 30% oxygen), increase oxygen delivery to up to FiO_2 0.4 (or 40% oxygen)
  - if possible, use dedicated suction procedure (e.g. special procedures on Draegar VN500) which automatically enriches oxygen during suction
- Avoid large swings in oxygenation, see **Oxygen saturation targets** guideline
- Ensure baby positioned appropriately for secretion clearance and stress reduction
- Ensure closed suction device is unlocked
- Check suction pressure – maximum 13 kPa. Use lowest pressure that effectively clears secretions
- Check ETT placement by confirming measurement at the lips is as documented

Measuring catheter advancement

- **Always follow manufacturer's instructions**

Method 1

- Note the printed number on the cut ETT
- Add length of adapter (usually 5 cm) to this to give the total distance of suction catheter advancement
- Stabilise the Y adaptor with one hand and advance catheter until calculated length is visible in irrigation port window. Catheter tip will be within 0.5–1 cm of the end of the ETT
- Note the nearest coloured band to the irrigation port window. Coloured bands allow for easy visualisation on subsequent suction procedures



Method 2

- Stabilise the Y adaptor with one hand
- Advance catheter until printed depth numbers on catheter align with the same numbers printed on the ETT
- Catheter tip will be within 0.5–1 cm of the end of the ETT

Performing suctioning

- Ensure suction catheter correctly advanced using either methods 1 or 2 (above)
- Depress thumb control valve and hold while withdrawing catheter slowly
- When tip of suction catheter reaches dome, release thumb control valve and stop withdrawing
- Procedure should take ≤15 sec
- Repeat procedure if necessary
- Do not use sodium chloride 0.9% instillation routinely. Sodium chloride 0.9% ≤0.5 mL may be instilled before suctioning if secretions are thick and tenacious and cannot be extracted by suctioning alone
- After each suctioning episode ensure the closed circuit is flushed with sodium chloride 0.9% according to manufacturer's instructions

If ETT clearance proves difficult with standard approach

- Advancement of the catheter to 0.5 cm below the ETT tip may be effective
- An experienced clinician should determine if this is appropriate
- See https://vimeo.com/428618217/9cc5803f88 for demonstration of this technique
- See **Airway clearance** guideline

DOCUMENTATION

- Record procedure in nursing documentation, noting distance tube was passed and colour of band on catheter tube closest to this measured distance

AFTERCARE

Equipment

- Leave thumb valve in locked position when not in use to prevent inadvertent activation
- Leave catheter tip in dome between use
- Device is single use only and replace every 24 hr as per manufacturer's guidance

Monitoring

- Ensure monitoring of heart rate and SpO_2 continues after procedure
- Auscultate baby's chest after procedure and document any changes observed
- If FiO_2 was adjusted before procedure, return to original settings, or ensure baby's target FiO_2 is maintained

Reporting adverse events

- Report adverse incidents using local risk management procedure

COMPLICATIONS

- Hypoxaemia
- Atelectasis
- Bradycardia

- Tachycardia
- Blood pressure fluctuations
- Decreased tidal volume
- Airway mucosal trauma
- Dislodgement of ETT
- Extubation
- Pneumothorax
- Pneumomediastinum
- Bacteraemia
- Pneumonia
- Fluctuations in intracranial pressure and cerebral blood flow velocity

FURTHER INFORMATION

- Further details on ETT closed suction can be found in the manufacturer's guidance

ENVIRONMENT

Lighting

Excessive and rapid changes in light levels may cause physiological instability, disturbed sleep and interfere with visual development. The thin eyelids of preterm babies may allow significant light to penetrate even if eyes closed

Aim	Method
• Provide flexible lighting to meet individual developmental needs and caregiver's needs • Ensure sufficient lighting for observation and care delivery • Promote optimal extra-uterine development and physiological stability • Reduce stress • Protect sleep • Development of normal circadian rhythms	• Keep lighting levels around 200–300 lux (moderate room lighting) • Monitor and audit light levels in nursery and baby's immediate environment regularly • Daylight preferable to artificial lighting. Protect babies from direct sunlight • Avoid direct bright light during feeding • Use dimmer switches and avoid sudden changes in light levels • Use incubator covers or canopies for preterm, sick or neurologically compromised babies ◦ keep a corner/flap up to allow safe observation • Protect babies in open cots from bright light until near term (37–40 weeks) • Where possible dim lights during the night to help create day-night cycle • Use individual task lighting for care and procedures. Shade baby's eyes throughout • Protect babies from phototherapy and bright lights in other bed spaces • Promote appropriate visual interactions with parents/carers • Protect babies from bright light for ≥18 hr following ROP screening

NOISE

- High levels of sound may cause:
  - baby distress
  - sleep disturbance
  - damage to hearing
  - impaired language and speech development
- A noisy environment affects behaviour and wellbeing of adults present, with impact on confidentiality, communication, stress levels and ability to concentrate, make decisions and perform fine motor tasks

Aim	Method
• Promote optimal extra-uterine development and physiological stability • Protect sleep • Maintain confidentiality and privacy • Promote normal speech and language development • Provide appropriate working environment	• Monitor noise levels in nursery and baby's immediate environment • Maintain ambient noise levels at 45 dB, with occasional peaks of 70 dB • Observe baby's cues to ensure noise levels do not indicate stress • Open packaging outside incubator • Keep monitor alarms and telephone ring tones at quiet but safe audible levels (silence alarms quickly) • Empty 'rainout' from ventilator tubing as soon as possible • Turn off suction when not in use • Close incubator doors and bins gently • Use incubator covers or canopies for preterm, sick or neurologically compromised babies ◦ keep a corner/flap up to allow safe observation • Keep conversations away from babies and speak quietly • Encourage parents/carers to speak softly to baby • Maintain quiet environment during oral feeding • Only use radios, portable music devices, musical toys etc. when clinically indicated and ensure other babies are not disturbed • Promote ≥1 'rest time' per day. Lower light and noise levels and suspend all routine procedures/ward rounds. Leave babies undisturbed to facilitate sleep. Encourage parents to view this as a quiet time to spend with baby • Reduce noise level as much as possible • Educate staff and parents regarding benefits of a quiet environment

INDICATIONS

- Comprehensive physical examination performed within <72 hr of life
- See: https://www.gov.uk/government/publications/newborn-and-infant-physical-examination-programme-handbook/newborn-and-infant-physical-examination-screening-programme-handbook
- See: https://www.gov.uk/topic/population-screening-programmes/newborn-infant-physical-examination
- Newborn assessments should take into account any impacts of race and ethnicity, especially in relation to skin colour assessment, jaundice and cyanosis. See RHO-Neonatal_Executive-Summary.pdf
- Includes screening for:
  - palatal defects
  - developmental dysplasia of the hip
  - congenital cataracts
  - cryptorchidism
  - heart murmurs
- General physical examination
- Examination has limitations and cannot identify all abnormalities that may be present in the newborn period
- Provides reassurance to parents and opportunity for discussion

EQUIPMENT

- Maternal and baby notes
- Stethoscope
- Ophthalmoscope
- Tongue depressor
- Torch
- Measuring tape

AIMS

- Identify congenital malformations
- Identify common neonatal problems and initiate management
- Continue with screening, begun antenatally, to identify need for specific interventions (e.g. immunisation)

PRE-PROCEDURE

- Before undertaking clinical examination, familiarise yourself with maternal history and pregnancy records, including:
  - maternal medical, obstetric and social history
  - paternal medical history, if available
  - family health, history of congenital diseases, hip dysplasia, congenital heart problems
  - identify drugs mother may have taken during pregnancy and in labour
  - health of siblings
  - identify pregnancy complications, blood tests, ultrasound scans, admissions to hospital
  - identify maternal blood group, presence of antibodies, serology results for sexually transmitted diseases
  - duration of labour, type of delivery, duration of rupture of membranes, condition of liquor
  - Apgar scores and whether resuscitation required
  - birth weight, gestational age, head circumference

Consent and preparation

- Introduce yourself to mother and gain verbal consent. Ask about particular concerns
- Keep baby warm and examine in quiet environment

PROCEDURE

Skin examination

- Hydration
- Rashes: including erythema toxicum, milia, miliaria, staphylococcal skin infection, *Candida*
- Pigmented lesions: naevi, congenital dermal melanocytosis (formerly called Mongolian blue spots), birth marks, café au lait spots
- Bruises: traumatic lesions, petechiae
- Cutis aplasia

- Tufts of hair other than on head
- Vascular lesions: haemangioma, port wine stain, simple naevus
- Colour: pink/cyanosis/jaundice/pallor/plethora – may be challenging to assess in some babies due to race or ethnicity. Assess sclera and gums for jaundice and mouth mucosa for cyanosis
- Consider transcutaneous bilirubinometer reading check for jaundice
- Consider pulse oximetry check for cyanosis
- Acrocyanosis
- Cutis marmorata

Facial examination
- General facial appearance to identify common syndromes

Eyes
- Shape
- Slant
- Size
- Position
- Strabismus
- Nystagmus
- Red reflex
- Presence of colobomata
- Discharges
- Check sclera for jaundice

Nose
- Nasal flaring
- Patency

Ears
- Shape
- Position
- Tags or pits

Mouth
- Size
- Cleft lip
- Symmetry of movement
- Swellings, Epstein's pearls, ranula, tongue-tie (for parental reassurance)
- Teeth
- Cleft palate, hard/soft palate, [by both inspection (using tongue depressor) and palpation]
- Sucking
- Check gums for jaundice
- Check mouth mucosa for cyanosis

Skull
- Palpate:
  - skull for sutures and shape/cranio-synostosis
  - swellings on scalp, especially crossing suture lines, cephalhaematoma
  - signs of trauma associated with birth (e.g. chignon from vacuum extraction)
  - subgaleal haemorrhage [see **Subgaleal haemorrhage (SGH)** guideline]
  - sutures for ridging or undue separation

Neck
- Swellings
- Movement
- Webbing
- Traumatic lesions from forceps delivery

Clavicles
- For fracture

Arms and legs
- Position and symmetry of movement
- Swelling and bruising

Hands and feet
- Extra digits (polydactyly)
- Syndactyly, clinodactyly, camptodactyly
- Palmar creases
- Skin tags
- Position and configuration of feet looking for fixed/positional talipes
- Overlapping toes

Hips
- Developmental dysplasia using Ortolani's and Barlow's manoeuvres [see **Developmental dysplasia of the hip (DDH)** guideline]

Spine
- Curvatures
- Dimples
- Sacrococcygeal pits
- Hairy tuft on skin overlying spine

Systems
- Examine (inspection, palpation, auscultation) each system

Respiratory
- Respiratory rate
- grunting
- nasal flaring
- Chest shape, asymmetry of rib cage, swellings
- nipple position, swelling/discharge/extra nipples
- Chest movement
- presence/absence of recession
- Auscultate for breath sounds

Cardiovascular
- Skin colour/cyanosis
- Palpate:
- precordium for thrills
- peripheral and femoral pulses for rate and volume
- central perfusion
- Auscultate for heart sounds, murmur(s), rate, rhythm
- Pulse oximetry check – see **Pulse oximetry (universal) screening** guideline

Gastrointestinal tract

Ask mother how well baby is feeding, whether baby has vomited and, if so, colour of vomit
Bilious vomiting may have a surgical cause and needs prompt stabilisation and referral

- Abdominal shape
- Presence of distension
- Cord stump for discharge or inflammation/umbilical hernia
- Presence and position of anus and patency
- Stools passed
- Palpate abdomen for tenderness, masses and palpable liver
- Auscultation is not routinely undertaken unless there are abdominal concerns

Genito-urinary system

Ask mother if baby has passed urine, and how frequently

- Inspect appearance of genitalia: any disorder of sexual development?
- Routine palpation of kidneys not always necessary as antenatal scans will have assessed presence

Male genito-urinary system
- Penis size (should be >1 cm)
- Position of urethral meatus. Look for hypospadias
- Inguinal hernia
- Chordee
- Urinary stream
- Scrotum for colour
- Palpate scrotum for presence of 2 testes and absence of hydrocele

Female genito-urinary system
- Presence of vaginal discharge (reassure parents about pseudomenstruation)
- Skin tags
- Inguinal hernia
- Proximity of genitalia to anal sphincter

Neurological system
- Before beginning examination, observe baby's posture
- Assess:
  - muscle tone, grasp, responses to stimulation
  - behaviour
  - ability to suck
  - limb movements
  - cry
  - head size in relation to body weight
  - spine, presence of sacral pits, midline spinal skin lesions/tufts of hair
- If neurological concerns, initiate Moro and stepping reflexes
- Responses to passive movements:
  - pull-to-sit
  - ventral suspension
- Palpate anterior fontanelle size (<3 cm × 3 cm) and tone

OUTCOME

Documentation
- Complete neonatal examination record in medical notes or electronic patient records and sign and date it. Also complete Child Health Record (Red Book) and/or in NIPE Smart if used
- Record any discussion or advice given to parents

Normal examination
- If no concerns raised, reassure parents of apparent normality and advise to seek advice if concerns arise at home
- GP will re-examine baby aged 6–8 weeks

Abnormal examination
- In first instance, seek advice from neonatal registrar/consultant
- Refer to postnatal ward guidelines for ongoing management
- Refer abnormalities to relevant senior doctor

EXCHANGE TRANSFUSION ● 1/5

Exchange transfusion replaces withdrawn baby blood with an equal volume of donor blood

Discuss all cases with local consultant and consider urgent transfer to tertiary unit

INDICATIONS

Haemolytic anaemia

- A newborn who has **not** had an in-utero transfusion (IUT) with a cord Hb <120 g/L and is haemolysing, may require urgent exchange transfusion to remove antibodies and correct anaemia:
  - if Hb <100 g/L: discuss **urgently** with consultant and proceed to exchange transfusion; avoid simple packed cell transfusions
  - if Hb 100–120 g/L: obtain 6-hrly bilirubin values and, if rapidly rising or close to exchange transfusion level (see **Jaundice** guideline), use intravenous immunoglobin (IVIG)
- A newborn who has had IUTs and whose Kleihauer test (may not be available in every hospital) demonstrates a predominance of adult Hb, anaemia can be managed using a top-up transfusion of irradiated, CMV-negative blood

Hyperbilirubinaemia

- Discuss promptly with consultant. If bilirubin values approaching guidance below; senior decision required:
  - guidance as determined by exchange transfusion line on gestation-specific NICE jaundice chart (see **Jaundice** guideline)
  - if bilirubin rises faster than 8.5 micromol/L/hr despite phototherapy, anticipate need for exchange transfusion

Other indications

- Chronic feto-maternal transfusion (chronic anaemia with normovolaemia)
- Disseminated intravascular coagulation (DIC)
- Severe non-haemolytic anaemia with normovolaemia

COMPLICATIONS

- Cardiac arrhythmias
- Air embolism
- Necrotising enterocolitis
- Coagulopathy
- Apnoeas and bradycardia
- Sepsis
- Electrolyte disturbances: hyperkalaemia, hypocalcaemia
- Hypoglycaemia
- Acidosis owing to non-fresh blood
- Thrombocytopenia
- Late hyporegenerative anaemia

PROCEDURE

Prepare

- Ensure full intensive care space and equipment available and ready
- Allocate 1 doctor/practitioner and 1 member of nursing staff, both experienced in exchange transfusion, to care for baby during procedure. Document their names in baby's notes
- Obtain written consent and document in baby's notes
- Use **Proforma** (at end of guideline) to document exchanged volumes
- Calculate volume of blood to be exchanged: double volume exchange removes 90% of baby's red cells and 50% of available intravascular bilirubin. Use:
  - term babies: 160 mL/kg
  - preterm babies: 200 mL/kg
- For anaemia without antibodies or hyperbilirubinaemia use single volume exchange. For term baby use 80 mL/kg, for preterm baby use 100 mL/kg
- Order appropriate volume (usually 2 units) of blood from blood bank, stipulating that it must be:
  - crossmatched against mother's blood group and antibody status, and (if requested by your blood bank) baby's blood group
  - CMV-negative
  - irradiated (shelf-life 24 hr) for any baby who has had an in-utero blood transfusion

- ≤4 days old and as fresh as possible
- plasma reduced red cells for 'exchange transfusion' (haematocrit 0.5–0.6), not SAG-M blood and not packed cells

Prepare baby
- Empty stomach using nasogastric tube (see **Nasogastric tube insertion** guideline) and keep baby nil-by-mouth
- Pay attention to thermoregulation, particularly if procedure to be performed under radiant heater
- Commence continuous cardiac, temperature and saturation monitoring
- If exchange for hyperbilirubinaemia, continue phototherapy during exchange transfusion

Document
- Blood pressure, respiratory rate, temperature, SpO_2 and heart rate every 15 min throughout exchange
- Volume of blood in and out with each cycle, and keep a running total (see **Proforma** at end of guideline)

Prepare blood
- Set up blood warmer early (aim for 37°C)
- do not use if:
  - intermittent bolus infusion i.e. single catheter exchange
  - blood is exposed to a radiant heater (risk of haemolysis)
- Check blood units as per hospital policy
- Connect donor blood to filter and prime blood giving set
- Connect to 4-way (if using UVC) or 3-way tap (outside the warmer) as indicated
- Gently squeeze donor blood bag before transfusion and every 15 min during transfusion, to prevent settling of red blood cells

During procedure
- Take arterial blood gas every 30 min during procedure (including pH, lactate, glucose, calcium and potassium readings)
- Ensure continued clinical monitoring for cyanosis, distress, pallor, vomiting or abdominal distension

If any change in baby's cardiorespiratory status, pause exchange by priming catheter with donor blood that will not clot. Discuss with consultant

Technique
- Ensure working area sterile

Either
- Isovolumetric or continuous technique
- continuous infusion of donor blood via a venous line with intermittent removal of baby's blood via an arterial line
- use umbilical venous or peripheral venous line for infusion and umbilical arterial or peripheral arterial line for removal of blood (see **Umbilical arterial catheterisation and removal, Umbilical venous catheterisation and removal** and **Arterial line insertion** guidelines)

Or
- Single catheter push-pull technique
- sequential withdrawal of baby's blood and infusion of donor blood via a UVC (see **Umbilical venous catheter: insertion and removal** guideline)

Isovolumetric or continuous technique
- Connect catheter bag, using Vygon connector, to 3-way tap attached to arterial line extension

Never leave arterial line open to catheter bag

- Connect donor blood to venous catheter
- Prior to the exchange transfusion, send pre-exchange bloods from the arterial line including; serum bilirubin, full blood count, blood culture, blood glucose, calcium, electrolytes, coagulation, liver function tests and bloodspot screening (if not already done)

- when exchange performed for reasons other than known blood group antibodies, send blood for G6PD screening and viral serology
- Determine transfusion rate and total transfusion time (aliquot = volume of blood to be removed)

Table 1

Weight	Aliquot size	Infusion speed
<1500 g	5 mL	1 mL/min (60 mL/hr)
1500−2499 g	10 mL	2 mL/min (120 mL/hr)
2500−3499 g	15 mL	3 mL/min (180 mL/hr)
≥3500 g	20 mL	4 mL/min (240 mL/hr)

- Take aliquots from arterial line at 5 min intervals
- Divide calculated total required volume (160ml x birth weight) by infusion speed (ml/min) to obtain total transfusion time

Example:
For a 3.5 kg term baby undergoing double volume exchange transfusion:
3.5 x 160 = 560 mL (**Total required volume**)
560 mL ÷4 mL/min = 140 min (**Total transfusion time**)
560 mL ÷ 20 mL aliquots = 28 separate aliquots

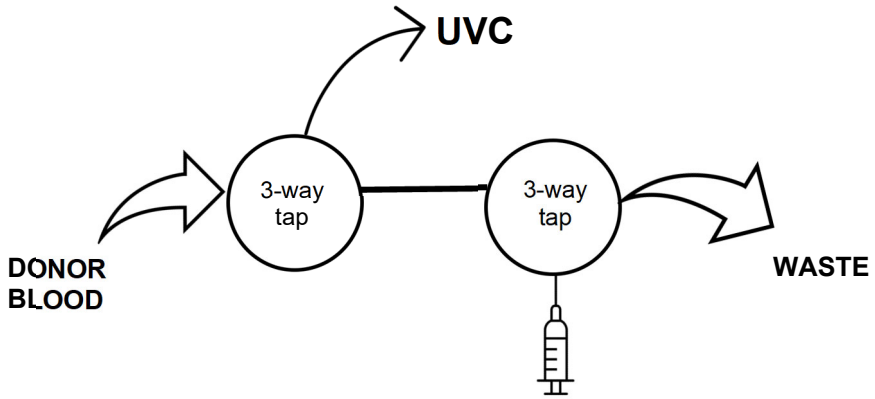
- Observe limb distal to arterial line at all times and document appearance. **If concerned, pause exchange and discuss with consultant**
- If exchange stopped for >2–3 min, discontinue procedure and ensure all lines are flushed with sodium chloride 0.9%
- Send last 'out' baby blood sample for post-exchange bloods including; serum bilirubin, full blood count, blood culture, blood glucose, calcium and electrolytes

Single catheter or 'push-pull' technique

- Connect catheter bag (using Vygon connector) and donor blood to 4-way tap and 4-way tap to UVC
- Do not use blood warmer with this method
- Remove blood from UVC using syringe and send for pre-exchange bloods as above in **Isovolumetric or continuous technique**

- Replace precise volume removed with donor blood, slowly using a syringe
- Each out-in cycle should replace ≤8.5 mL/kg and take ≥5 min; start with smaller aliquots (10 mL) and increase to 20 mL (if baby stable and weight allows) only after 30 min
- Discard 'out' baby blood into catheter bag
- Continue out-in cycles every 5 min (maximum aliquot with each cycle) until complete
- Send last 'out' baby blood sample for post-exchange bloods as above

Figure 1: Set-up for single catheter push-pull technique



POST PROCEDURE

Immediate

- When Hb and bilirubin in final 'out' sample known, check with consultant before removing all lines

- Complete documentation (volumes in/out, and all observations) (see proforma at end of guideline) and add to baby's clinical notes
- Recommence feeds 4–6 hr after completion
- Monitor blood sugar 4-hrly until acceptable on 2 consecutive occasions (see **Hypoglycaemia** guideline)
- Update parents

Intermediate

- In babies receiving antibiotics, a repeat dose may be required – discuss with consultant
- Bloodspot screening to be taken at appropriate time (see **Bloodspot screening** guideline)

Follow-up

- Neurodevelopmental follow-up in all babies who have undergone exchange transfusion
- Repeat full blood count at intervals (likely 1–2 weekly but to be determined individually) for ≥6 weeks, to detect anaemia secondary to ongoing haemolysis

EXCHANGE TRANSFUSION ● 5/5

Proforma

NAME:
HOSPITAL ID:
DATE OF BIRTH:
DATE OF EXCHANGE TRANSFUSION:

Once number of needed aliquots has been calculated, draw clear lines on proforma to block out additional aliquot lines

Weight	**kg**
Transfusion (160 mL/kg term or 200 mL/kg preterm)	**mL/kg**
Volume to be exchanged	**mL**
Aliquot size	**mL**
Aliquot number	

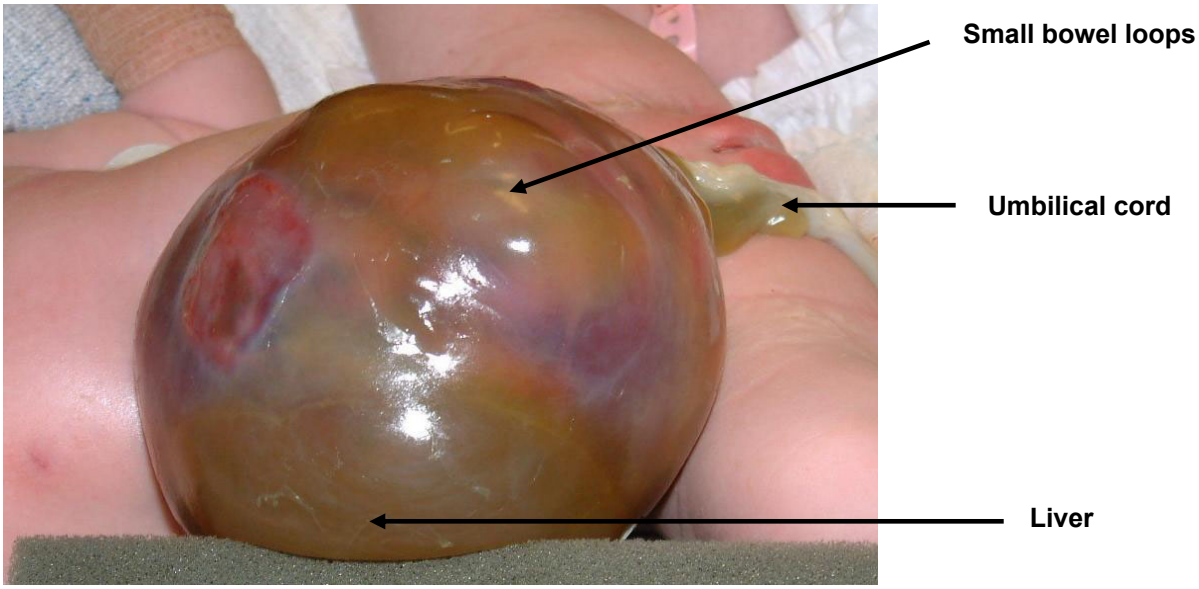
Aliquot number	Time	In		Out		Total Balance In − Out =
		Vol aliquot mL	Total mL	Vol aliquot mL	Total mL	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

EXOMPHALOS – INITIAL MANAGEMENT ● 1/3

DEFINITION

Congenital anterior abdominal wall defect, resulting in herniation of the abdominal contents through the umbilicus. Herniated viscera are covered by a sac

- *Exomphalos minor:* no liver in sac, defect diameter <5 cm
- *Exomphalos major:* sac contains liver (see photograph), defect diameter ≥5 cm



- Key issues to be aware of:
  - rupture or damage to protective sac
  - association with other major abnormalities (cardiac or chromosomal)
- Depending on individual patient factors, can be managed either by:
  - exomphalos minor: early surgical closure of the defect (as a neonate)
  - exomphalos major: delayed surgical closure, after epithelisation of the sac using dressings

Diagnosis and antenatal care

- Majority diagnosed antenatally
- Often associated with chromosomal and other abnormalities
- Multi-professional discussions needed to carefully plan antenatal and postnatal care
- If suspected antenatally
  - refer to fetal medicine department for further assessment
  - refer to paediatric surgery for antenatal counselling
- Give parents information leaflet
- Aim to deliver in hospital with appropriate NNU with either postnatal transfer to paediatric surgical unit or management by paediatric surgical outreach team at the NNU

Pre-delivery

- Liaise with on-call team at paediatric surgical centre before making arrangements for elective delivery

Delivery

- Experienced paediatrician/ANNP to attend delivery
- Clamp umbilical cord only after careful assessment of the umbilical defect (to avoid any bowel present at base of cord)
- Use plastic cord clamp (not artery forceps) on umbilical cord ≥10 cm away from where normal umbilical cord starts to avoid bowel injury
- Dry baby
- Provide resuscitation as required. Avoid prolonged mask ventilation
- Nurse in supine position
- Pass a size 8 Fr nasogastric tube (NGT) and fix securely with tape (see **Nasogastric tube insertion** guideline)
- Empty stomach by aspirating NGT with 10–20 mL syringe. If <20 mL fluid aspirated, check position of tube. Place tube on free drainage by connecting to a bile bag

EXOMPHALOS – INITIAL MANAGEMENT ● 2/3

- Put nappy on baby, taking care to fold it down under the defect
- Place baby's legs and trunk, feet first, into a sterile plastic bag, to protect the defect and reduce fluid loss. Pull the draw-string under the arms, so that both arms are outside the top of the bag
- Show baby to parents and transfer to NNU

In NNU

- Careful physical examination by experienced neonatal practitioner. If baby has a major lethal congenital abnormality, local consultant to decide whether referral for management is appropriate. May require discussion with on-call consultant surgeon. If the decision is not to transfer, inform surgical unit
- Nurse in supine position
- Insert IV cannula. Avoid vein which could be used for long line e.g. antecubital fossa, long saphenous or scalp
- Avoid umbilical lines
- Take blood for:
  - culture
  - FBC, CRP and clotting screen, including fibrinogen
  - U&E
  - blood glucose and venous blood gas
- Crossmatch sample will be taken at surgical centre
- Send 1 bloodspot on neonatal screening card marked as 'pre-transfusion' with baby to surgical centre
- Administer fluid boluses as indicated by baby's condition
- Start maintenance IV fluids (see **Intravenous fluid therapy** guideline)
- Give vitamin K (see **Vitamin K** guideline)
- Leave NGT on free drainage and aspirate NGT 4-hrly with a 20 mL enteral syringe
- Replace nasogastric losses mL-for-mL using sodium chloride 0.9% IV with potassium chloride 10 mmol in 500 mL bag
- Start broad spectrum antibiotics (see **Neonatal Formulary**) including metronidazole IV
- Monitor blood glucose 4–6 hrly
- Swab sac and send for culture and sensitivity
- Take a photograph of the exomphalos, with parent's consent
- Remove bowel bag and protect the sac by covering with a non-adhesive dressing (Jelonet) and sterile gauze, until assessed by paediatric surgical outreach team
- Discuss baby's condition and treatment plan with parents and ensure they have seen the baby before transfer. Take photographs for parents

Referral

- Refer baby to planned paediatric surgical unit e.g. BCH. This may require a conference call with on-call surgeon to discuss urgency of transfer; an emergency surgical procedure is normally not indicated
- Some babies may not require transfer to paediatric surgical unit and can sometimes be managed on NNU
  - for BCH this may include transfer to BWH for neonatal surgical outreach service
- Complete nursing and medical documentation for transfer. Electronically transfer any X-rays to surgical unit (or obtain copies of X-rays)
- Ensure mother's details included (including ward phone number if an inpatient and own number if discharged) as if operation necessary and an individual with parental responsibility unable to attend surgical unit, surgeon will require verbal telephone consent
- Ensure baby's documentation includes:
  - whether vitamin K has been given
  - name of referring consultant
  - whether parents received antenatal counselling
  - mother's name, ward (if admitted) and her contact details
- If the neonatal surgical decision is to perform a delayed closure of the exomphalos, the recommended dressing is manuka honey gel covered with a honey net dressing, sterile gauze and crepe bandage
  - ensure baby has been seen by neonatal surgical outreach team before applying dressing
- If exomphalos is to be managed with dressings on NNU this will be supported by the surgical neonatal outreach service

While awaiting transfer

- Reassess hourly for further fluid boluses and, if necessary, give either sodium chloride 0.9% or human albumin solution (HAS) 4.5% 10 mL/kg

EXOMPHALOS – INITIAL MANAGEMENT ● 3/3

- If evidence of a coagulopathy, treat appropriately (see **Coagulopathy** guideline)
- Aspirate NGT 4-hrly
- Replace nasogastric losses mL-for-mL with sodium chloride 0.9% IV with potassium chloride 10 mmol in 500 mL bag. Leave NGT on free drainage

Useful Information

- https://bwc.nhs.uk/download.cfm?ver=3512

BACKGROUND

- Approximately 4% of babies develop skin necrosis as a result of extravasation of an IV infusion
- A small proportion of these babies develop long-term cosmetic or functional compromise
- Cochrane review shows that centrally placed catheters may cause extravasation as often as peripheral cannulae
- Extravasation can lead to both short and long-term complications
- Use this guideline to define the grading and management of subcutaneous extravasation injuries in babies, either from peripheral or central lines

IV SITE

Precautions

- Examination of IV line site before and during infusion
- Document in daily summary (electronic or patient notes):
  - site of insertion
  - peripheral or central line and
  - if any concerns e.g.:
    - redness
    - swelling around the site or in limb
- Extravasation can be due to:
  - cannula piercing vessel wall or
  - distal venous occlusion causing backpressure and increased vascular permeability
- Limiting the IV pump cycle to 1 hr **may** minimise the extent of tissue damage from extravasation providing the entry site is observed concurrently
- Degree of tissue damage due to extravasation is dependent upon:
  - volume of infusate, its pH and osmolality
  - the properties of any drug(s) being infused

ASSESSMENT

Table 1: Grading of extravasation injuries

Grade 1	Grade 2	Grade 3	Grade 4
• IV device flushes with difficulty • Pain at infusion site • No swelling or redness	• Pain at infusion site • Mild swelling • Redness • No skin blanching • Normal distal capillary refill and pulsation	• Pain at infusion site • Marked swelling • Skin blanching • Cool blanched area • Normal distal capillary refill and pulsation	• Pain at infusion site • Very marked swelling • Skin blanching • Cool blanched area • Reduced capillary refill • +/- arterial occlusion • +/- blistering/skin breakdown/necrosis

- See **Pain assessment and management** guideline

Investigations

- No specific investigations required. However, if wound appears infected:
  - wound swab
  - FBC
  - CRP
  - blood culture
  - start appropriate antibiotics [see **Infection (late onset)** guideline]

ACUTE MANAGEMENT

Table 2

Grade 1 and Grade 2	Grade 3	Grade 4
• Stop infusion immediately • Remove cannula and splints/tapes • Elevate limb	• Stop infusion immediately • Remove constricting tapes • Leave cannula *in situ* until review by doctor/ANNP • Withdraw as much of the drug/fluid as possible via the cannula • Elevate limb • Inform tissue viability nurse	• Stop infusion immediately • Remove constricting tapes • Leave cannula *in situ* until review by doctor/ANNP • Withdraw as much of the drug/fluid as possible via the cannula • Photograph lesion – provided no delay in further treatment • Discuss with consultant whether to irrigate affected area (see below) • Elevate limb • Inform tissue viability nurse/registrar/consultant +/- plastic surgery team

- Most extravasation injuries are of Grades 1 and 2 and do not require extensive intervention
- Grade 3 and 4 injuries have a greater potential for skin necrosis, compartment syndrome and need for future plastic surgery, depending on type of solution extravasated

Compartment syndrome

- Risk of compartment syndrome from large volume extravasations to limbs in small babies
- significant swelling
- pallor
- weak or absent pulse
- delayed capillary refill

Management

- Stop infusion
- Elevate affected limb as much as is possible
- Prompt referral to surgical team for assessment and consideration of fasciotomy

Irrigation of affected area

- A Cochrane review concluded that there is insufficient evidence to assess the effects of irrigation, with or without hyaluronidase
- The procedure itself may cause scaring whilst not all extravasation injuries leave scars
- Irrigation should only be considered in the most serious injuries with large volume extravasation and/or caustic solutions (e.g. calcium)
- See below for details of procedure

Wound dressings

- When choosing wound dressing, consider need to prevent:
- further trauma
- epidermal water loss
- contractures by allowing a full range of limb movements
- Dressings must be:
- easy to apply to small body surface areas
- sterile
- suitable for use in humidified/incubator environments
- thin hydrocolloid dressing (to blistered, broken or necrotic skin) and refer to tissue viability team

Documentation
- Document extent and management of the injury in medical record

FOLLOW-UP AND REVIEW
- Determined by grade of extravasation
- neonatal medical staff review minor grades after 24 hr
- neonatal/plastic surgery staff/tissue viability nurse review Grades 3 and 4 within 24 hr to assess degree of tissue damage and outcome of irrigation procedure if performed

Other considerations
- **Family-centred care** – inform parents of extravasation injury and management plan

Special considerations
- Infection prevention – observe standard infection prevention procedures
- Complete an incident report for Grade 3 and 4 extravasations

IRRIGATION OF EXTRAVASATION INJURIES
Procedure
- Withdraw as much of the drug and or fluid as possible via cannula or catheter
- Infiltrate the site with lidocaine 1% 0.3 mL/kg before to reduce pain
- Using a scalpel, make 4 small incisions around periphery of extravasated site
- Insert blunt Tuohy needle, or pink cannula with needle removed, into each incision in turn, and irrigate damaged tissue with hyaluronidase* followed by sodium chloride 0.9%. It should flow freely out of other incisions
- Massage out any excess fluid using gentle manipulation
- Cover with paraffin gauze for 24–48 hr

***Preparation of hyaluronidase**
- Reconstitute a 1500 unit vial of hyaluronidase with 3 mL of water for injection
- Use 1–2 mL shared between each incision then irrigate with sodium chloride 0.9%

When irrigating with sodium chloride 0.9%, use discretion depending on baby's weight

Documentation
- Person performing procedure must document in baby's medical record

FOLLOW-UP OF BABIES DISCHARGED FROM NEONATAL UNIT● 1/2

INDICATIONS

- Birth weight <1501 g
- Gestation <32 weeks
- Requiring IPPV or CPAP for more than a few hours
- Bronchopulmonary dysplasia with prolonged mechanical ventilation at 36 weeks' postmenstrual age
- Postnatal steroids given <33 weeks' gestation
- Significant cranial ultrasound abnormality on final scan on NNU
- Acute neonatal encephalopathy grade 2 or 3
- Seizures (of whatever cause)
- Neonatal meningitis
- Neonatal herpes simplex infection
- Blood culture positive neonatal sepsis
- Abnormal neurological examination at discharge
- Severe retinopathy of prematurity
- Neonatal abstinence syndrome requiring treatment (see **Abstinence syndrome** guideline)
- Exchange transfusion for any reason/immunoglobulin for hyperbilirubinaemia/in-utero transfusion or serum bilirubin >10 x gestational age (weeks) in preterm babies
- Major congenital anomalies (consider early referral to general paediatrician)
- Persistent hypoglycaemia
- Consultant discretion
- Babies who have undergone surgery in early neonatal period

PROCEDURE

- Refer to neonatal follow-up clinic

Follow-up timetables

- These tables are a guide to usual number of appointments according to each neonatal condition
- Adjust follow-up to individual needs
- Follow local policy to book appointments with relevant professionals

High-risk preterm babies born <30 weeks

- See at:
  - 6 weeks after discharge
  - EDD + 3–5 months
  - EDD + 9–12 months
  - EDD + 2 yr
- At each appointment measure height, weight and OFC and perform neurological, medical and developmental assessments

All other babies

- See at**:**
  - 6–8 weeks after discharge
  - EDD + 3–5 months
  - EDD + 9–12 months
  - EDD + 2 yr
- Exceptions:
  - babies who underwent surgery in the neonatal period do not need to be seen at EDD + 2 yr
  - term babies who were ventilated/received CPAP, babies with culture positive sepsis and babies who has persistent hypoglycaemia only need to be seen at 6–8 weeks after discharge
- See **Developmental follow-up of children born preterm** guideline

Babies ≥34 weeks with transient problems (e.g. mild jaundice, feeding problems, hypoglycaemia, culture-negative sepsis etc.)

- May require specific advice to community team/GP about monitoring/follow-up, but usually do not need neonatal follow-up
- See relevant guideline for follow-up for other conditions e.g. syphilis, HIV, hepatitis, cardiac murmurs etc.

FOLLOW-UP OF BABIES DISCHARGED FROM NEONATAL UNIT● 2/2

FURTHER MANAGEMENT AT CLINIC

Neurodevelopmental problems identified

- Refer to child development centre and/or specialist services e.g. physiotherapist, speech and language therapist and dietitian according to baby's individual needs
- Refer to patch consultant community paediatrician
- referral may be made at time problem identified or later if more appropriate for the family
- For complex medical problems, e.g. ongoing cardiac or respiratory disease, shared neonatal follow-up

Babies with problems identifiable early

- For babies with Down syndrome, severe hypoxic ischaemic encephalopathy or at consultant discretion, involve patch consultant community paediatrician and pre-school therapy team early, before discharge if appropriate
- For babies with concurrent medical problems (e.g. cardiac problem, chronic lung disease), arrange co-ordinated follow-up (decided on individual basis following discussion between community and neonatal consultants)
- Refer children with impaired vision and/or hearing to consultant community paediatrician

GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD) ● 1/2

DEFINITION

- Gastro-oesophageal reflux (GOR): passage of gastric contents into the oesophagus with/without regurgitation and vomiting
- GORD: when GOR leads to troublesome symptoms that affect daily functioning and/or complications

RECOGNITION AND ASSESSMENT

- Physiological regurgitation and episodic vomiting are frequent in babies
- In baby with recurrent regurgitation or 'spitting' carry out physical examination and take thorough history, including:
  - age of onset of symptoms
  - feeding and dietary history
  - pattern of regurgitation/spitting/vomiting
  - family medical history
- Physiological GOR seldom starts before aged 1 week or after aged 6 months

Presentation

- Babies may present with fussiness, crying and arching with/without spitting
- Desaturations, bradycardia and apnoea may be seen in preterm babies
  - little evidence for a causal relationship

DIAGNOSTIC INTERVENTIONS

- There is no evidence for use of barium studies, ultrasound scan, endoscopy or salivary pepsin measurement to diagnose GORD
  - may be used to exclude other pathology in complex cases
- Usefulness of pH-metry and pH impedance studies is limited
  - may be recommended to correlate acid and non-acid reflux with symptom events

TREATMENT

- If no impact of symptoms on feeding, growth or acquisition of developmental milestones, treatment or intervention is not required

Positioning

- Head elevation and left lateral positioning in monitored babies recommended

Feed modification

- Trial reduction of feed volumes and increasing feed frequency with appropriate monitoring of weight and length measurements
- Encourage and support mothers to continue breastfeeding

Feed thickeners

- Thickened feeds may be trialled in babies aged >34 weeks' gestation
  - may provide symptom relief
  - Carobel® made according to manufacturer's instructions
- If no improvement with feed thickeners, alginates can be used
  - Gaviscon Infant® in accordance with manufacturer's instructions
    - 1 dose equals half dual sachet

Do not use Carobel® and Gaviscon Infant® together as this will cause the milk to become too thick

Specialist formulas

- If symptoms persist, a 2−4 week trial of a protein hydrolysate or amino acid formula/exclusion of cow's milk protein from a breastfeeding mother's diet can be trialled under supervision of neonatal dietician
- If symptoms persistent/complex, refer to GI specialist for further clinical evaluation

Pharmacological

- No evidence to support the role of drugs in management of GORD in babies
  - includes use of H2 receptor antagonists, proton pump inhibitors, domperidone and prokinetics

GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD) ● 2/2

PARENT INFORMATION

- GORD in preterm babies is common and parents can be reassured of the normality of GOR (supported by Bliss parent information https://www.bliss.org.uk/parents/about-your-baby/medical-conditions/reflux)

GASTROSCHISIS● 1/5

DEFINITION

Congenital defect of the anterior abdominal wall resulting in herniation of bowel. The herniated viscera are not covered by any surrounding membranes and are exposed to amniotic fluid during pregnancy and air following delivery

DIAGNOSIS

- Majority of cases diagnosed on antenatal ultrasound scan
- Refer mother to fetal medicine department
- Refer parents to paediatric surgery for antenatal counselling
- Give parents gastroschisis information leaflet. Offer opportunity to visit NNU where baby will be admitted following delivery

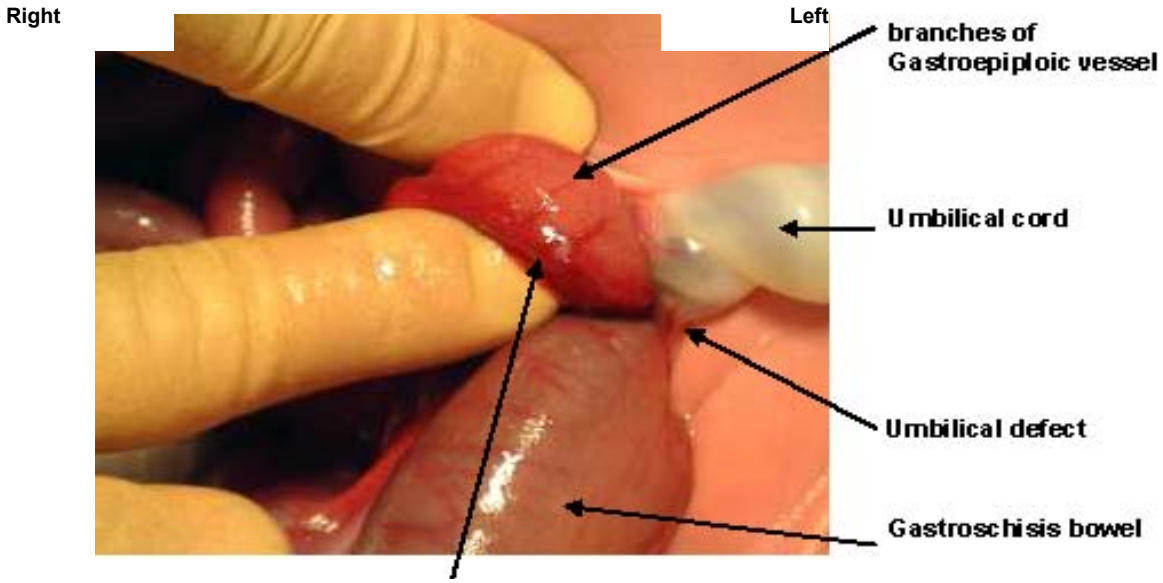
PRE-DELIVERY

- Gastroschisis is a surgical emergency, delivery should be planned in a hospital with an appropriate level NNU aiming to transfer to paediatric surgical unit within 4 hr of birth
- Antenatal and postnatal care must be carefully planned. Communication between groups of professionals and the parents is essential
- Case to be discussed with local paediatric surgery unit before delivery
- If no surgical cot is available there and delivery cannot be postponed, then neonatal team will need to identify potential cot at nearest alternative paediatric surgical centre
- As soon as baby delivered, inform transport team

DELIVERY

- Neonatal tier 2 staff attend delivery
- Take a size 8 Fr nasogastric tube (NGT) and a gastroschisis bag (often labelled as a bowel bag). This is a large sterile bag which can be closed around baby's chest with a draw-string
- Babies become cold very quickly and experience fluid loss from the exposed bowel. Perform the following as rapidly as possible:
  - clamp cord with plastic clamp (**not** artery forceps) placed approximately 5 cm from baby's abdomen, checking cord clamp is securely fastened. If in doubt, apply second plastic cord clamp adjacent to the first
  - dry upper part of baby quickly
  - initiate resuscitation as required. Avoid prolonged mask ventilation, if resuscitation prolonged, intubate
  - pass NGT (see **Nasogastric tube insertion** guideline) and fix securely
  - empty baby's stomach by aspirating NGT with a 10 or 20 mL syringe. If <20 mL of fluid aspirated, check position of tube
  - place tube on free drainage by connecting to a bile bag
- If stomach protruding through defect (**Image 1**), ensure it is decompressed

Image 1

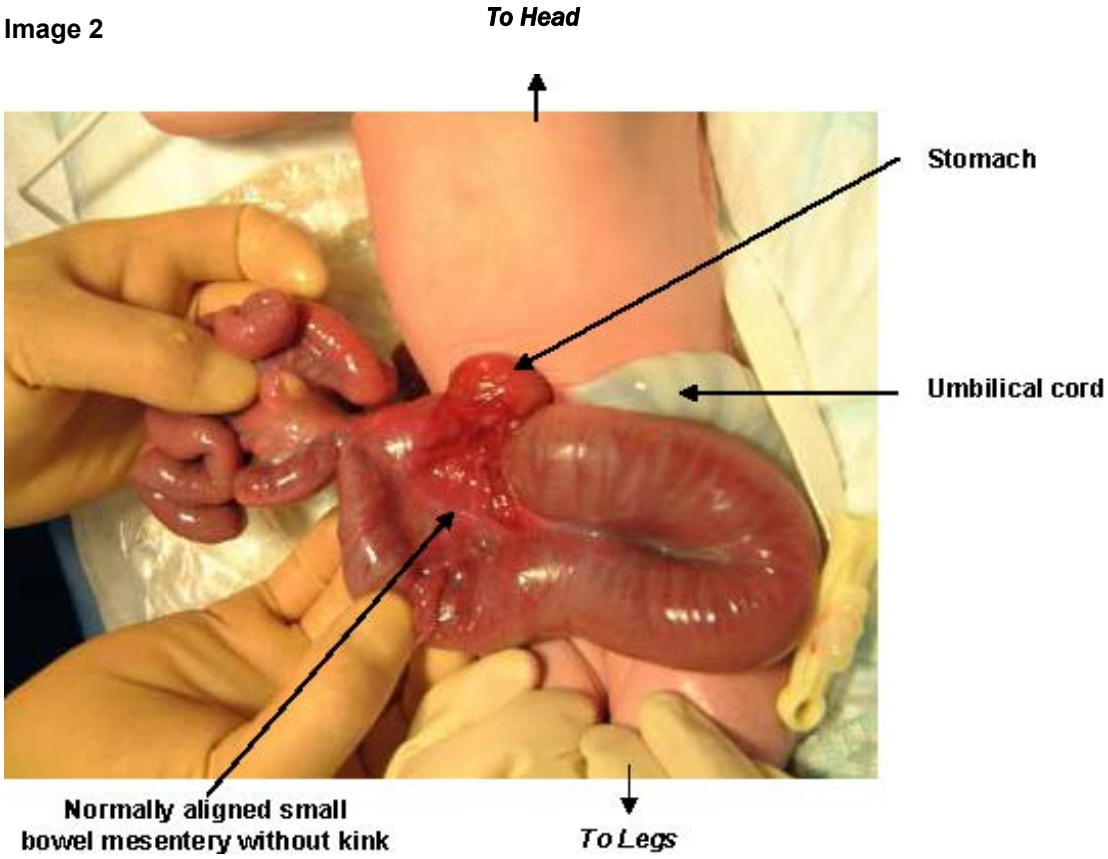


Gastroepiploic vessel is a longitudinal vessel running along the greater curvature of the stomach and helps identify the stomach from the bowel

Image 1

- If stomach cannot be decompressed, call surgical tier 2 for further advice. Failure to decompress the stomach can cause pressure on the bowel mesentery resulting in bowel ischaemia
- Aspirate NGT gently. If stomach fails to decompress, gently manipulate to facilitate this, whilst aspirating the NGT
- Take great care not to cause reflux of stomach contents up the oesophagus around the tube but simply aid drainage
- Assess colour and alignment of bowel
- Using sterile gloves handle the bowel carefully to ensure it is not twisted or kinked and there is no traction on the mesentery (**Image 2**)

Image 2



- Place baby onto the same side as the defect (usually right) and support bowel on a folded nappy placed slightly under baby
- Check perfusion of bowel. If vascular compromise suspected, contact on-call neonatal consultant
- if compromise persists, inform surgical team immediately
- Place baby's legs and trunk into gastroschisis bag, feet first, and pull draw-string under baby's arms, so both arms are outside of the bag
- Alternatively, cover and support intestines with cling film from upper chest to lower abdomen, holding intestines in central position
- ensure intestines are visible
- do not wrap cling film tightly as this will reduce perfusion
- Show baby to parents and transfer to NNU
- Check global perfusion using central capillary refill time (CRT)
- Check perfusion of bowel again immediately before transfer to NNU and at least every 15 min thereafter

IN NNU

- Inform transport co-ordination team immediately as this is a time critical transfer (aim to transfer to paediatric surgical unit within 4 hr of birth)
- if baby ventilated and transferring to BCH, call KIDS NTS (see **Transport and retrieval** guideline) (will conference call paediatric intensive care unit to arrange bed)
- if baby ventilated and transferring to a unit other than BCH, call KIDS NTS (see **Transport and retrieval** guideline) once PICU bed in referral hospital confirmed
- Monitor perfusion and alignment of bowel at least every 15 min
- Insert IV cannula, avoid potential long line veins
- Avoid umbilical lines
- Infuse either sodium chloride 0.9% or human albumin solution (HAS) 4.5% 20 mL/kg over 1 hr and start routine IV maintenance fluids (see **Intravenous fluid therapy** guideline)
- Aspirate NGT again and record volume. Replace NG losses mL-for-mL with sodium chloride 0.9% + 10 mmol potassium chloride/500 mL IV

- Monitor central perfusion, using central CRT at least every 15 min. Give further fluid boluses as required to maintain a normal CRT (<2 sec). Babies with gastroschisis have a high fluid requirement until the herniated bowel is replaced in the abdomen
- Start IV antibiotics (benzyl penicillin, gentamicin **and** metronidazole) – see **Neonatal Formulary**
- Give vitamin K IM (see **Vitamin K** guideline)
- Discuss baby's condition and treatment plan with parents and ensure they have seen baby before transfer
- Inform staff at surgical unit baby is ready for transfer. Have available:
- name
- gestational age
- weight
- ventilatory and oxygen requirements
- mother's name and ward (if mother admitted), including contact number if possible (for consent)

Blood samples

Baby

- Blood culture
- FBC and clotting studies, including fibrinogen
- U&E
- Blood glucose
- Capillary/venous blood gas
- Check with surgical unit if sample from baby for group and save, Coombs or crossmatch required (e.g. Birmingham Children's Hospital do **not** need these before transfer as these are done at surgical unit)
- Send 1 bloodspot on neonatal screening card marked as 'pre-transfusion' with baby to surgical unit

Mother

- Obtain sample of mother's blood for crossmatch
- sample tube must be clearly hand written and labelled with mother's name, date of birth, NHS number, and date and time of collection
- complete form
  - add baby's details to ensure it is clear sample relates to mother of baby being transferred (this information is required by surgical unit blood bank)

AWAITING TRANSFER TO SURGICAL UNIT

- Continue to assess bowel perfusion and alignment every 15 min
- Reassess baby's fluid requirements hourly. If fluid boluses required, give sodium chloride 0.9% 10 mL/kg IV
- If evidence of a coagulopathy, treat with fresh frozen plasma (FFP) or cryoprecipitate, as appropriate (see **Coagulopathy** guideline)
- Aspirate NGT hourly and replace aspirate volume, mL-for-mL with sodium chloride 0.9% with 10 mmol potassium chloride/500 mL IV
- Leave NGT on free drainage

DOCUMENTATION

- Complete nursing and medical documentation for transfer. Electronically transfer any X-rays to surgical unit (or obtain copies of X-rays)
- Ensure mother's details included (including ward phone number if an inpatient and own number if discharged) as if operation necessary and an individual with parental responsibility unable to attend surgical unit, surgeon will require verbal telephone consent
- Ensure baby's documentation includes:
- whether vitamin K has been given
- name of referring consultant
- whether parents received antenatal counselling
- mother's name, ward (if admitted) and her contact details

TRANSFER TO SURGICAL UNIT

- Inform surgical unit that transfer is underway
- Place baby in transport incubator, taking care to transfer bowel and mesentery in a supported, non-kinked position. Keep stomach empty

- place baby on side of defect and support bowel on a folded nappy just slightly under baby. Check bowel perfusion immediately and at least every 15 min
- ensure mother's blood, baby's pre-transfusion bloodspots, letters for surgical team and all documentation accompany baby

During transport

- Carry out and document usual observations, include bowel perfusion and alter its position if necessary

Arrival at surgical unit

- Record bowel perfusion and alignment

Useful information

- Parent information: https://bwc.nhs.uk/download.cfm?doc=docm93jijm4n2151

GOLDEN HOUR
Preterm babies <28 weeks' gestation ● 1/3

INTRODUCTION
The care preterm babies receive within the first few hours and days has a significant impact on their long-term outcomes. The CESDI Project 27–28 study highlighted the importance of good early care for preterm babies with particular reference to effective resuscitation (see **Resuscitation** guideline)

AIM
To stabilise baby and perform all procedures required within the first hour **after** birth

BEFORE DELIVERY

Nurses	Doctors/ANNPs
• Identify nurse responsible for admission and redistribute existing babies • Ensure incubator set up and pre-warmed with humidity set at maximum • Check monitor and appropriate connections • Set oxygen saturation targets to 90–94% by setting alarm limits to 90% and 96% • Ensure ventilator and Neopuff™ plugged in and checked • Ensure appropriate size face masks available • Prepare suction and catheters • Ensure transport incubator pre-warmed and cylinders full • Ensure endotracheal tube (ETT) sizes 2.5 and 3.0 are available • Set up trolley for umbilical arterial catheter (UAC) and umbilical venous catheter (UVC) beside incubator • Prepare infusion fluids for UAC and UVC • Take resuscitation bag and saturation monitor to delivery	• Registrar/experienced ANNP is responsible for early care of babies <28 weeks' gestation • counsel parents appropriate to gestation • <27 weeks, discuss delivery with consultant • Prescribe infusions for UAC and UVC • Check resuscitaire in delivery suite • ensure overhead heater switched on and set to maximum • set peak inspiratory pressure (PIP) at 20 cm H_2O and FiO_2 at 0.21 • check saturation monitor and probe available • ECG monitor and leads (if available) • Prepare plastic bag

GOLDEN HOUR
Preterm babies <28 weeks' gestation ● 2/3

AFTER DELIVERY

Nurses	Doctors/ANNPs
• Keep baby warm with plastic bag and hat • Assist with resuscitation • Accurate time-keeping including resuscitation and procedures • Attach oxygen saturation probe to right hand • Do not attach ECG leads <26 weeks' gestation. Only use if 26–27 weeks or if concern with critical cardiac arrhythmia • Assist with ETT fixation • Pre-warm surfactant and prepare surfactant administration equipment • Set up transport incubator (if used locally) and transfer baby to it • Ensure baby labels in place before transport • Ensure midwives have taken cord gases • Transfer baby to NNU	• Competent practitioner or tier 2 staff to attend • Perform optimal cord clamping, delaying clamping by 1 min, ensuring baby kept warm • Only cut cord before 1 min if baby requires immediate resuscitation, which cannot be provided with cord intact • Place baby in plastic bag • Use warmed humidified gases and thermal mattress as required • Cover baby's head with appropriate size warmed hat • Assess colour, tone, heart rate and breathing • If baby breathing regularly, commence CPAP at 5–6 cm H_2O • If baby not breathing regularly, follow resuscitation algorithm as per NLS guidance • See **Resuscitation** guideline • If continued IPPV necessary, intubate • Consider early surfactant on labour ward, ensure appropriate ETT position and fix securely before administering. See **Surfactant replacement therapy – including less invasive surfactant administration (LISA) technique** guideline • Review baby before transfer to NNU (some units use transport incubator): ◦ air entry ◦ colour ◦ heart rate ◦ saturation • Complete joint resuscitation record • Show baby to parents • Senior member of staff to talk briefly to parents • Transfer baby to NNU

GOLDEN HOUR
Preterm babies <28 weeks' gestation ● 3/3

FIRST HOUR FROM BIRTH

Nurses	Doctors/ANNPs
• Aim for at least 1:1 nursing care for first hour • Transfer to incubator in plastic bag • Weigh baby in plastic bag • Leave baby in plastic bag until incubator reaches adequate humidity • Attach baby to ventilator or non-invasive support equipment and reassess ABC • Monitor heart rate and saturation • Record blood pressure + baseline observations • **Do not** use ECG leads on babies <26 weeks' gestation • Measure axillary temperature on arrival • Insert nasogastric tube (NGT) • Assist doctor/ANNP with lines • Give vitamin K • Give first dose of antibiotics • Commence prescribed infusions – do not wait for X-ray confirmation of umbilical lines provided they bleed back following insertion • Take photograph for parents • Ensure parents have access to information and support for early expressing of breast milk (aim for ≤2 hr of birth)	• Reassess ABC • Split tasks between doctors/ANNPs **Doctor/ANNP A** • Prescribe weight-dependent drugs and infusions, and vitamin K • Prepare blood test forms and blood bottles • Start admission notes (**BadgerNet**) **Doctor/ANNP B** • If not ventilated, check respiratory effort on CPAP • Check ETT position clinically and administer surfactant if not previously given on labour ward • Check ventilation – review tidal volume and chest movement • Commence with tidal volume of 5 mL/kg ◦ targeted tidal volume ventilation should be commenced ◦ maximum PIP set appropriately and reviewed • If not oxygenating/ventilating, consider increasing tidal volumes ◦ if tidal volume >5 mL/kg or vigorous chest movement, reduce tidal volume target without waiting for first gas ◦ check saturation and adjust FiO_2 to keep saturation 91–95% • Insert UAC and UVC through hole in plastic bag ◦ commence infusions as soon as line secured ◦ give IV antibiotics • Take blood for: ◦ FBC ◦ group and DCT ◦ blood culture ◦ blood glucose ◦ pre-transfusion bloodspot ◦ arterial gas • Defer peripheral IV cannula insertion unless unable to gain umbilical access • Once lines inserted, request X-rays • Document ◦ ETT position ◦ NGT length ◦ UAC and UVC positions at time X-ray taken • Document X-ray review in notes • Update parents and document in notes

Once baby set up – minimise handling
Hands off – Eyes on

GROUP B STREPTOCOCCAL COLONISATION OF MOTHER ● 1/1

Based on RCOG Green Top Guideline No. 36 2017 update
See also **Infection in first 72 hours of life** guideline

BACKGROUND

- Mortality from Group B streptococcal (GBS) infection:
- term: 2–3%
- preterm: 20–30%
- Baby infected with GBS has a 1 in 19 risk of dying and 1 in 14 survivors will have long-term disability
- 90% of babies with early onset GBS infection are symptomatic within 12 hr of birth
- A mother colonised with GBS during pregnancy has a 50% risk of colonisation in subsequent pregnancies
- Colonised mother who had a previous baby affected by GBS has a greater chance of having another affected baby, than a colonised mother who has not had an affected baby
- Two-thirds of invasive infections occur 0–6 days of life (early onset), one-third occur 7–90 days after birth (late onset)
- Intrapartum antibiotic prophylaxis (IAP) does not prevent late onset GBS infection

INTRAPARTUM ANTIBIOTIC PROPHYLAXIS

- Offer IAP to:
- mother identified as colonised with GBS during pregnancy
  - any growth of GBS is significant (urine, rectum or vagina), whether identified accidentally/routinely
- mother with previous affected baby
- preterm labour (including without known GBS colonisation)
- IAP not required for planned delivery by caesarean section with intact membranes and in the absence of labour

MANAGEMENT OF BABY

- No action required for term baby whose mother received IAP >4 hr before delivery
- If IAP was indicated but not given/declined or if delivery was within 4 hr of first dose of IPA:
- baby to be reviewed for signs of infection
- neonatal observations at 0, 1, and 2 hr and then 2-hrly until 12 hr
- early discharge (within 24 hr of birth) to be avoided
- RCOG does NOT recommend blood culture and/or antibiotic prophylaxis
- If baby appears unwell follow **Infection in first 72 hours of life** guideline

ADVICE FOR PARENTS

- Parents/carers should seek urgent medical advice if they are concerned baby shows any of the following:
- abnormal behaviour (e.g. inconsolable crying or listlessness)
- unusually floppy
- onset of difficulties feeding or intolerance of feeds
- temperature <36°C or >38°C not explained by environmental factors
- change in skin colour

GROWTH MONITORING ● 1/3

DEFINITION

- Routine accurate measurement and documentation of weight, length and occipitofrontal circumference (OFC)

AIM

- To detect any abnormal growth patterns, including faltering growth

INTRODUCTION

- Neonatal nutrition and resulting postnatal growth are major determinants in the short- and long-term outcomes of preterm neonates
- Optimal postnatal nutrition and growth are associated with more positive later health and developmental outcomes
- Consider proportional growth rather than absolute weight gain
- Preterm babies who demonstrate suboptimal growth in the early years have a higher probability of poorer cognitive developmental outcomes, while those with excessive weight gain have an increased risk of childhood and adult obesity, cardiovascular disease and diabetes
- Plot measurements of weight, length and OFC on appropriate age and sex specific growth chart to allow assessment of adequate velocity and proportionate growth
- measurements to be undertaken by qualified member of staff trained in the use of the equipment in presence of parents as per FICare plan
- Involve parents/carers with all growth monitoring procedures

WEIGHT

Frequency

- Weigh all babies on admission to NNU/transitional care unit
- Weigh at least 3 times/week while an inpatient
- Plan weighing schedules taking into account developmental care needs and FICare principles
- If baby too unstable to be weighed for >5 consecutive days, and incubator does not have inbuilt scales:
- calculate weight-for-age from appropriate growth chart
- use as working weight (assuming baby is following their previous centile line) to ensure adequate fluids, enteral and parenteral nutrition, and drugs administered
- reinstate routine weighing once baby stable
- If baby unstable, assess for fluid overload – impacts on accuracy of weighing for growth monitoring

Equipment

- Class III electronic baby scales or incubator with inbuilt scales (if available) – accurate to 5 g
- All scales to be:
- tested and recalibrated annually
- cleaned between patients in accordance with local infection control policy

Method

- Wash and sanitise hands and equipment as per local infection prevention policy
- Weigh baby in nappy only (no clothing)
- Use swaddled weighing for optimal developmental care
- wrap baby in a warm, pre-weighed blanket
- deduct weight of swaddle blanket, [no need to deduct weights of nappy or medical equipment (e.g. NGT, CVL, cannula etc.)]
- Record actual calculated weight on unit documentation/**BadgerNet**
- ≤999 g: to nearest 5 g
- ≥1 kg: to nearest 10 g
- Plot weight at least weekly on **BadgerNet** or sex appropriate WHO **Neonatal and infant close monitoring growth chart** [see chart or refer to RCPCH website (www.growthcharts.rcpch.ac.uk) for instructions on use]
- In babies <2 kg: calculate velocity of weight gain in g/kg/day at least weekly

- Use World Health Organisation fetal weight gain as a guide:

Gestational age (weeks)	WHO fetal weight gain (g/kg/day)
23–25	20–23
26–29	17–20
30–34	13–17
35–37	10–13

- If parent is present baby will benefit from skin-to-skin contact before returning to incubator/cot

LENGTH

Frequency

- Measure all babies on admission to NNU and weekly thereafter coinciding with a weigh day whilst inpatient

Equipment

- ≤33 weeks or <45 cm: use Leicester Incubator Measure
- ≥33^{+1} weeks: use length mat
- Requires 2 people to obtain an accurate measurement (1 may be parent/carer alongside trained member of staff)

Never use a tape measure to measure length

Method

- Wash and sanitise hands and equipment as per local infection prevention policy
- Measure baby supine, lying flat, ensuring no clothing or nests restrict extension
- Remove hat or ventilation/non-invasive ventilation hat ties
- Preterm babies may be measured in a nappy
- Term babies to be measured naked, no nappy
- **Operator 1**: place fixed headpiece against crown of baby's head, stabilising head by gently cupping palms of hands over baby's ears
- **Operator 2**: gently place palm of hand over baby's knee encouraging extension, sliding base plate up to meet the soles of the feet
- If baby settled and relaxed, take 3 measurements to ensure consistency
- Record length in cm to nearest 0.1 cm
- Plot length weekly on **BadgerNet** or sex appropriate WHO **Neonatal and infant close monitoring growth chart** [see chart or refer to RCPCH website (www.growthcharts.rcpch.ac.uk) for instructions on use]
- Calculate velocity of linear growth in cm/week monthly
- aim 1.4 cm/week as steady linear growth in preterm baby

OFC

Frequency

- Measure on admission to NNU and weekly thereafter coinciding with a weigh day while inpatient

Equipment

- Disposable paper tape measure

Method

- Wash and sanitise hands as per local infection prevention policy
- Remove hat or head gear that may obstruct measurement
- Using disposable paper tape measure, take measurement at the widest part of baby's head
- above ears, midway between eyebrows and hairline at the front, and to the occipital prominence at the back of the head
- Record in cm to nearest 0.1 cm on NNU documentation

GROWTH MONITORING ● 3/3

- Plot OFC weekly on **BadgerNet** or sex appropriate WHO **Neonatal and infant close monitoring growth chart** [see chart or refer to RCPCH website (www.growthcharts.rcpch.ac.uk) for instructions on use]
- Calculate velocity of OFC growth in cm/week monthly
- aim 0.9 cm/week as steady OFC growth in preterm baby

INTERPRETATION

- Growth charts are a tool to monitor growth and growth velocity
- After initial weight loss of 7–10%, reaching a nadir at days 3–4, nutritional strategies should aim for baby to regain birth weight by days 7–10, followed by growth along a target centile
- Babies with slow growth velocity (less than expected over 1 week period), growth failure or whose growth parameters continue to fall across centiles into week 3 of life, to have a full nutritional review
- include calculation of any parenteral nutrition received (not only prescribed), and enteral nutrition intake
- If combined nutritional intake falls short of recommended requirements: optimise nutritional intake (see **Nutrition and enteral feeding** guideline)
- if growth remains suboptimal: see **Nutrition and enteral feeding** guideline – **Inadequate growth**
- If baby exhibiting suboptimal growth: refer to NNU nutrition team or neonatal/paediatric dietitian

DISCHARGE

- Transfer key information regarding growth to Personal Child Health Record (PCHR) or Red Book
- Must include birth and discharge weight, length and OFC

HEARING SCREENING ● 1/2

INTRODUCTION

- Early intervention improves the outcome for babies with a congenital hearing deficit
- Screening for congenital deafness is undertaken through the NHS Newborn Hearing Screening Programme (NHSP) by trained screeners according to national guidelines. They are automatically informed of all births and will ensure babies are screened
- Neonatal staff must understand how their local programme is organised, the risk factors for congenital deafness and know how to work with the screeners

INDICATIONS

Who

- All babies are eligible for screening, except:
  - microtia/external ear canal atresia
  - neonatal bacterial meningitis or meningococcal septicemia
  - confirmed congenital cytomegalovirus (cCMV)
  - programmable ventriculo-peritoneal shunts
- Neonatal staff **must** refer babies with meningitis to audiology for an urgent assessment (NHSP referral to be completed and handed to the screeners who will book a diagnostic appointment)
- Screeners will refer babies with non-patent canal for urgent diagnostic assessment

PROCEDURE

Consent

- Screening can only be performed with parental consent
  - screeners will obtain verbal consent from parents (if present) before screening
  - if baby on NNU and parents absent, screeners will leave an explanatory leaflet and gain verbal consent from parents during their visit to NNU or over the telephone

How

- Oto-Acoustic Emissions (OAE) +/- Automated Auditory Brainstem Response (AABR) according to national 'Well baby' or 'NICU' protocols
  - neonatal staff must inform screeners if baby has ever spent >48 hr on NNU so that NICU protocol can be used
  - babies on transitional care are screened using the 'Well baby' protocol (unless previously on NNU for >48 hr)

When

- Screen only when baby has reached 34 weeks (corrected age)

Where

Well babies

- Screening is performed as an inpatient before discharge or in the community (see **Table** for local details)

NNU babies

- Arrange screening as close to discharge as possible, when baby is well enough to test and preferably once major medical treatment, ototoxic or other drug treatment complete
- Do not screen babies transferring to another NNU
- Complete screening of babies on NNU >48 hr by 44 weeks (corrected age)

FOLLOW-UP

- Neonatal staff must ensure all babies diagnosed with bacterial meningitis are referred for an urgent audiology assessment and are not screened
- Screeners will arrange routine follow-up according to screening results and presence of other specific risk factors
- Babies with cCMV may need to be seen earlier [timescale agreed with paediatrician to allow early antiviral treatment to commence (if required)]
- Other babies who did not meet the indications for screening must be seen by audiology within 4 weeks of the decision not to screen/recovery from acute episode, and by 44 weeks' gestation

HEARING SCREENING ● 2/2

Risk factors

- Neonatal staff must inform the screener of the following risk factors in order that appropriate follow-up at aged 7–9 months can be arranged:
  - confirmed or possible congenital infection (rubella, toxoplasmosis)
  - cranio-facial anomalies, cleft palate, deformed pinnae (not simple ear tags)
  - syndromes associated with hearing loss (Down's, Waardenburg, Alport, Usher etc.)
  - baby has been treated with ECMO
- Babies with the following risk factors are not followed up by audiology, but data is collected for audit purposes:
  - severe jaundice (at exchange level)
  - multiple abnormalities with neurodegenerative/neurodevelopmental disorder
  - mechanical ventilation >5 days
- Screener will determine presence of other risk factors before screening:
  - family history of permanent hearing loss in childhood
    - those with first-degree relative will be followed up in audiology

FURTHER INFORMATION

- Detailed information available from NHSP website: https://www.gov.uk/topic/population-screening-programmes/newborn-hearing

Table 1: Local details

• **Alexandra Hospital, Redditch** • **Russells Hall Hospital, Dudley** • **Shrewsbury and Telford Hospitals** • **New Cross Hospital** • **Worcestershire Royal Hospital**	Usually performed by trained staff in the community Babies on NNU usually screened before discharge
• **Midland Metropolitan University Hospital** • **Birmingham Heartlands Hospital** • **Birmingham Women's Hospital** • **Good Hope Hospital** • **Hereford County Hospital** • **Manor Hospital** • **Royal Stoke University Hospital**	Screening for all babies usually performed while still an inpatient, usually at bedside
• **Sandwell Hospital MLU** • **Solihull Hospital MLU**	Screening performed as outpatient unless baby transferred into a main maternity/NNU

HEART FAILURE ● 1/3

DEFINITION

- Cardiac failure occurs when the heart is unable to pump sufficient blood to meet metabolic demands of body tissues
- underlying cause may be cardiac or non-cardiac

Common causes

Cardiac

- Left-to-right shunt (see **Increased left-to-right shunt**)
- Arrhythmia
- Hypoplastic left heart syndrome
- Critical aortic stenosis
- Coarctation
- Interrupted aortic arch

Non-cardiac

- Sepsis
- Hypoxia
- Anaemia
- Polycythaemia
- Fluid overload
- AV malformation
- Pulmonary hypertension

Clinical differentiation between an obstructed systemic circulation and severe sepsis is extremely difficult as a murmur and weak pulses can be common to both.
For a baby* in extremis*, presence of abnormal pulses alone is sufficient indication to start a prostaglandin infusion until a cardiac lesion has been excluded by echocardiography (see* Prostaglandin infusion *guideline)

SIGNS OF CARDIAC FAILURE

- Tachycardia
- Tachypnoea
- Hepatomegaly
- Excessive weight gain
- Hypotension
- Murmur
- Abnormal femoral pulses
- weak femoral pulses (in obstructive left heart lesions – femoral pulses may not be absent if duct is still patent)

INVESTIGATIONS

- Blood gases including lactate
- Baseline bloods including FBC, U&E, LFT
- Blood culture
- Chest X-ray – look for cardiomegaly and pulmonary oedema
- Pre and postductal saturations
- postductal saturations can be considerably lower than preductal in aortic arch defects and PPHN (a difference of >2% is significant)
- ECG
- Echocardiogram

TREATMENT OF CARDIAC FAILURE DUE TO OBSTRUCTIVE HEART DISEASE

If left-sided obstructive lesion suspected, treat with inotropes and use diuretics cautiously

Resuscitation

Airway

- Routine intubation not indicated

- Intubate and ventilate babies presenting collapsed or with obvious cyanosis in association with cardiac failure
- If apnoea occurs secondary to a prostaglandin infusion, intubate baby but do not alter infusion

Breathing

- See **Ventilation: volume targeted** guideline
- Ventilate with PEEP 5–6 cm
- Adjust ventilation to maintain:
- $PaCO_2$ 5–6 kPa
- pH >7.25

Circulation

- Vascular access with 2 IV cannulae or umbilical venous catheter (UVC) (see **Umbilical venous catheter: insertion and removal** guideline)
- Prostaglandin infusion to maintain ductal patency (see **Prostaglandin infusion** guideline)
- open duct with dinoprostone (prostaglandin E2, prostin E2), see **Neonatal Formulary**. Start at 5–10 nanogram/kg/min, may be increased to 50 nanogram/kg/min, but only on cardiologist advice
- Monitor blood pressure invasively

Cardiac output

- Signs of poor cardiac output include:
- tachycardia
- low BP
- acidosis
- high lactate
- poor peripheral perfusion with cold extremities
- **When cardiac output low:**
- ensure adequate intravascular volume
- correct anaemia
- discuss with regional cardiac centre for choice of inotropes

SUBSEQUENT MANAGEMENT – TRANSFER

Baby must be kept warm and normoglycaemic

- Discuss further management and transfer with regional cardiac centre
- Babies who respond to a prostaglandin infusion may not need transferring out-of-hours
- Appropriately skilled medical and nursing staff are necessary for transfer

Intubation

An intubated baby requires a cardiac centre ITU bed; do not intubate routinely for transfer

- Intubate if:
- continuing metabolic acidosis and poor perfusion
- long-distance transfer necessary
- inotropic support needed
- apnoea
- recommended by cardiac team

DISCHARGE FROM CARDIAC CENTRE

Baby may go home or return to a paediatric ward or NNU, possibly on a prostaglandin infusion whilst awaiting surgery or for continuing care after a palliative procedure (e.g. septostomy)

Management plan

- Regardless of outcome, obtain a management plan from cardiac centre, defining:
- acceptable vital signs (e.g. saturations)
- medication, including dosage
- follow-up arrangements

INCREASED LEFT-TO-RIGHT SHUNT

RECOGNITION AND ASSESSMENT

Definition

- Any lesion causing increased pulmonary blood flow
- Usually presents when pulmonary resistance falls after 48 hr
- Size and type of lesion will influence time of presentation

Differential diagnosis

- AVSD
- Partial AVSD
- VSD
- Truncus arteriosus
- PDA

Investigations

- Chest X-ray looking for fluid overload
- Echocardiogram

MANAGEMENT

- If in cardiac failure, give immediate dose of diuretic
- May require maintenance diuretics (discuss with cardiologist)
- usually furosemide 1 mg/kg twice daily (oral/IV) and amiloride 100 microgram/kg twice daily (oral)
- Discuss with cardiac centre for definitive management and follow-up

HEPATITIS B

- Check mother's hepatitis B status **before delivery**

Antenatal

- Midwife to inform obstetrician, neonatologist, Public Health team and GP of plan to immunise
- Hepatitis B immunoglobulin (HBIG) issued by Public Health England (PHE) via local consultant microbiologist
- order well in advance of birth
- if twins, order 2 doses
- if declined, refer to legal team for anticipatory order for vaccine within 24 hr of birth

Labour

- When an HBsAg positive mother arrives in labour or for caesarean section, labour ward must inform on-call neonatal team

Postnatal

- For all newborns, check screening results of mother's antenatal tests
- If antenatal testing not done, request urgent maternal HBsAg test
- Mother may breastfeed

IMMEDIATE POSTNATAL TREATMENT OF BABY

Table 1: To which babies

Maternal status	Vaccine required by baby	Immunoglobulin (HBIG) required by baby
HBsAg positive, HBeAg positive	Y	Y
HBsAg positive, HBeAg negative, HBe antibody (anti-HBe) negative	Y	Y
HBsAg positive where e markers have not been determined	Y	Y
Acute hepatitis B during pregnancy	Y	Y
HBsAg positive and baby <1.5 kg	Y	Y
HBsAg positive, anti-HBe positive	Y	N
HBsAg positive and >10^6 iu/mL Hepatitis B DNA in antenatal sample	Y	Y
Other high-risk group	Y	N

- Give low-birth-weight and premature babies full neonatal dose hepatitis B vaccine
- Give HBIG and hepatitis B vaccine to babies with birth weight <1.5 kg born to mother with hepatitis B, regardless of mother's HBeAg status

When

- Give hepatitis B vaccine within 24 hr of birth, ideally as soon as possible after delivery
- When indicated HBIG should be given with hepatitis B vaccine ideally within 24 hr of birth, but no later than 7 days of birth

What

- Give hepatitis B vaccine 0.5 mL IM. **Caution:** brands have different doses [e.g. Engerix-B® 10 microgram 0.5 mL (recommended), HBvaxPro® 5 microgram 0.5 mL]
- HBIG 250 units additionally given to babies of highly infectious mothers (see **Table 1**)
- Monitor babies born <28 weeks' gestation for 72 hr after HBIG

How

- Use 2 separate injection sites for hepatitis B vaccine and HBIG, in anterolateral thighs (not buttocks)
- Low-birth-weight babies ≤1.5 kg can be given the HBIG injection divided into smaller amounts and given into different sites, but should still receive a full 250 units
- Give hepatitis B vaccine IM, except in bleeding disorder where it may be given deep subcutaneously

Relationship to other immunisations
- No need to delay BCG following HBIG
- Hepatitis B vaccine may be given with other vaccines but use separate site. If same limb used, give vaccines >2.5 cm apart

Documentation
- Record immunisation in Red Book
- Notify Child Health Information Services using unscheduled immunisation form
- Advise GP when next doses due

Breastfeeding
- Mother may breastfeed

SUBSEQUENT MANAGEMENT

Further doses
- Second dose at 1 month
- Give appointment for next dose or ensure agreement to give vaccine at GP practice

1 yr follow-up
- Book 1 yr hospital blood test before neonatal discharge
- Check child's HBsAg status at aged 1 yr before hepatitis B vaccine if UKHSA 1 yr dried blood spot (DBS) for hepatitis B not already done by GP between aged 12–18 months
- if HBsAg positive refer to infectious disease or liver team for further management

Table 2: Hepatitis B vaccine schedule for routine and at risk baby immunisation programmes

Age	Routine childhood programme		Babies born to hepatitis B infected mothers	
Birth	x*		✓	Monovalent HepB (Engerix B® 10 microgram or HBvaxPRO® 5 microgram) (with HBIG if indicated)
4 weeks	x		✓	Monovalent HepB (Engerix B® 10 microgram or HBvaxPRO® 5 microgram)
8 weeks	✓	DTaP/IPV/Hib/HepB (Infanrix hexa®)	✓	DTaP/IPV/Hib/HepB (Infanrix hexa®)
12 weeks	✓	DTaP/IPV/Hib/HepB (Infanrix hexa®)	✓	DTaP/IPV/Hib/HepB (Infanrix hexa®)
16 weeks	✓	DTaP/IPV/Hib/HepB (Infanrix hexa®)	✓	DTaP/IPV/Hib/HepB (Infanrix hexa®)
18 months	✓	DTaP/IPV/Hib/HepB (Infanrix hexa®)	✓	DTaP/IPV/Hib/HepB (Infanrix hexa®) Test for HBsAg

*** Babies born to hepatitis B negative mothers but going home to a household with another hepatitis B infected person may be at immediate risk of infection – give a monovalent dose of hepatitis B vaccine before discharge**

HEPATITIS C

Antenatal
- High-risk groups:
- intravenous drug users (IVDU) or women with partners who are IVDU
- from a country of intermediate or high prevalence (≥2%) of chronic hepatitis C, including Africa, Asia, the Caribbean, Central and South America, Eastern and Southern Europe, Middle East and Pacific Islands
- living in homeless hostel/rough sleeping

Procedure
- Pregnant women at risk for hepatitis C infection should be screened at antenatal visits

HEPATITIS B AND C 3/3

- If the initial results are negative in women with ongoing risk factors this **should be repeated in the third trimester**
- In the third trimester, if maternal HCV Ab is positive (indicating past or current infection), request **Hepatitis C RNA NAAT (viral load)**
- If hepatitis C RNA positive, discuss with mother/family regarding testing of baby at 18 months and inform neonatal team
- If maternal hepatitis C RNA negative, baby not at risk and does not require testing

Follow-up

- Discuss with neonatal unit consultant and arrange follow-up in clinic at 18 months
- Discharge baby summary to GP to include containing information on further investigations and follow-up plan
- Inform mother and family of arranged follow-up appointments

Documentation

- Document hepatitis C follow-up visits in Red Book to ensure health visitor aware and baby followed up

Breastfeeding

- Mother may breastfeed

Adoption and fostering

- If high risk factor (see **Antenatal**) for HCV and/or maternal status not known
- Aged <18 months
- check hepatitis C antibody status at screening or first contact at Looked After Clinic
- if serology positive, repeat serology at 18 months Aged ≥18 months
- check hepatitis C antibody status at screening or first contact at Looked After Clinic, if positive, refer to paediatric infectious disease consultant

HERPES SIMPLEX VIRUS (HSV) ● 1/1

Urgently treat suspected HSV e.g. vesicles, seizure or positive HSV PCR

RECURRENT HSV OR CAESAREAN SECTION

(History of genital herpes before third trimester)

- No swabs or treatment
- Educate parents on good hand hygiene to prevent transmission
- Observe on postnatal ward, discharge after neonatal examination at 24 hr
- Advise to seek medical help if skin, eye or mucous membrane lesions, lethargy/irritability, poor feeding
- If clinical evidence of sepsis:
  - surface swabs and blood for HSV PCR
  - start empirical aciclovir 20 mg/kg 8-hrly IVI over 1 hr pending results

PRIMARY HSV

(First episode of genital herpes ≤6 weeks before vaginal delivery)

- Strict infection control
- Swab baby's nasopharynx, conjunctiva, mouth and rectum in viral transport medium for HSV PCR
- Check baby's ALT and send blood for HSV PCR
- Start aciclovir 20 mg/kg IVI (over 1 hr) 8-hrly
- If ALT abnormal or other signs of infection (including skin lesions) send CSF for HSV PCR
- Recommend breastfeeding unless herpetic lesions around nipple

UNKNOWN HSV CONTACT

- If risk of HSV:
  - neonatal sepsis with ALT >50 IU/L
  - maternal symptoms possible HSV e.g. increasing vulval pain
  - postnatal contact with HSV e.g. baby kissed by person with history of cold sores
  - new parental sexual partner in pregnancy (ask GUM to take history)
- Swab any lesions and take blood – for HSV PCR
- Start empirical aciclovir 20 mg/kg 8-hrly IVI over 1 hr pending results

TREATMENT

Duration of aciclovir IV

- If neonatal HSV PCR negative: stop aciclovir
- If active infection ruled out: stop aciclovir
- If skin, eye or mouth lesions: lumbar puncture
  - if CSF HSV negative: aciclovir IV for 14 days
  - if CSF HSV positive: repeat LP at 14 days and if negative stop at 21 days
- If any confirmed HSV disease, then give suppressive therapy with aciclovir 300 mg/m^2 oral 8-hrly for 6 months

HYPOXIC ISCHAEMIC ENCEPHALOPATHY (HIE) INCLUDING PREPARATION FOR ACTIVE COOLING ● 1/6

RECOGNITION AND ASSESSMENT

The following points are useful when making a diagnosis of HIE:

- History of a sentinel event, e.g. abruption or uterine rupture
- History of fetal/intrapartum distress or acidosis
- Low Apgar scores and/or delayed onset of respiration requiring resuscitation
- Symptoms or signs of encephalopathy
- characteristic feature of many cases of HIE is an **evolving** encephalopathy – babies get worse and then get better
- Signs of multi-organ involvement usually occurs in association with a moderate to severe encephalopathy
- Exclusion of other likely causes of encephalopathy

WHEN TO CONSIDER FOR THERAPEUTIC HYPOTHERMIA

Treatment criteria

- **Babies ≥36 weeks' gestation, meeting criteria A, B and C aged ≤6 hr**
- Babies 35^{+0}–35^{+6} weeks' gestation but meeting criteria A, B and C aged ≤6 hr, discuss with cooling centre
- limited evidence of benefit of TH in babies <35 weeks' gestation and some evidence of increased risk of complications
- If in doubt about the suitability of any baby for cooling, discuss with cooling centre

Criterion A
At least ONE of the following:

- Apgar score ≤5 at 10 min after birth
- Continued need for resuscitation, including endotracheal or mask ventilation at 10 min after birth (does not include those receiving PEEP or CPAP alone)
- Acidosis within 60 min of birth (defined as umbilical cord, arterial or capillary pH <7.0)
- Base deficit ≥16 mmol/L in umbilical cord or any blood sample (arterial, venous or capillary) within 60 min of birth

Criterion B

- Moderate-to-severe encephalopathy, consisting of altered state of consciousness (lethargy, stupor or coma) AND at least one of the following:
- hypotonia
- abnormal reflexes including oculomotor or pupillary abnormalities
- absent or weak suck
- clinical seizures

Criterion C

- Babies meeting Criteria A and B should be assessed for at least 30 min of amplitude integrated EEG (aEEG)
- There must be one of the following:
- normal background (upper margin >10 μV and lower margin >5 μV) with some seizure activity
- moderately abnormal activity (upper margin >10 μV and lower margin <5 μV)
- suppressed activity (upper margin <10 μV and lower margin <5 μV)
- continuous seizure activity

If aEEG is not available and baby meets criteria A and B commence cooling

Neonatal encephalopathy evolves with time.
Babies who meet Criterion A but are neurologically normal at the time of assessment should be reassessed several times during the first 6 hours of life

HYPOXIC ISCHAEMIC ENCEPHALOPATHY (HIE) INCLUDING PREPARATION FOR ACTIVE COOLING ● 2/6

Neurological assessment – repeat and document at regular intervals as babies go through pathway of care:

Parameter	Mild	Moderate	Severe
Level of consciousness	• Normal • Hyper alert	• Lethargic	• Stuporous/comatose
Spontaneous activity when awake or aroused	• Active • Vigorous does not stay in one position	• Less than active • Not vigorous	• No activity whatsoever
Posture	• Moving around and does not maintain only one position	• Distal flexion, complete extension or frog-legged position	• Decerebrate with/without stimulation (all extremities extended)
Tone	• Normal – resists passive motion	• Hypotonic or floppy, either focal or general	• Completely flaccid like a rag doll
Primitive reflexes	• Suck: normal • Moro: normal	• Suck: weak • Moro: incomplete	• Suck: completely absent • Moro: completely absent
Autonomic system	• Pupils: normal size, reactive to light • Heart rate: normal >100 bpm • Respirations: normal	• Pupils: constricted, <3 mm but react to light • Heart rate: bradycardia (<100 bpm variable up to 120 bpm) • Respirations: periodic irregular breathing effort	• Pupils: fixed dilated, not reactive to light • Heart rate: variable inconsistent rate, irregular, may be bradycardic • Respirations: completely apnoeic requiring positive pressure ventilation
Seizures	• None	• Common focal or multifocal seizures	• Uncommon (excluding decerebration) or frequent seizures

REFERRAL

Consent

- Discuss cooling treatment with parents as soon as practically possible. It is not necessary to wait for informed consent before starting cooling
- Document discussions in baby's notes

In addition

- Request cord gases (if not already obtained)
- Request midwives save placenta for histological examination

Passive cooling

- As soon as decision made for cooling, referring unit to telephone cooling centre and to begin passive cooling
- document this time as 'age when passive cooling commenced'
- document baby's temperature at this time
- begin passive cooling by switching off overhead heater and active heating in a transport incubator
- Nurse baby in an open Babytherm® cot with heater switched off
- If baby nursed in an incubator, open portholes
- Nurse baby naked apart from a nappy

Continuous rectal temperature monitoring

- Insert a rectal probe to 6 cm and commence continuous rectal temperature monitoring

- Target rectal temperature 33–34°C

Regular communication between referring unit and cooling centre is vital

- Once baby accepted by a cooling centre, contact neonatal transport team to arrange transport of baby and complete cooling proforma
- Use servo controlled total body cooling mattress (if available) before arrival of neonatal transport team. Use fans or gloves filled with cold water **only** if continuous rectal temperature monitoring is in place and cooling mattress is not available

Never use ice filled gloves to cool a baby as this can bring the temperature down to dangerously low and uncontrolled levels

STABILISATION PHASE

Passive cooling

- Use referral form from: https://www.teamwmcn.nhs.uk/neonatal-guidelines
- **Ensure baby's temperature does not fall below 33ºC**. Document every 15 min
- Follow **Passive cooling protocol flowchart**
- Care continues in referring unit with advice from cooling centre as required
- If not already intubated at delivery [most babies will need to be intubated for transfer (see **Intubation** guideline)] discuss with receiving consultant and newborn transfer service
- If possible, insert umbilical arterial and venous catheters and monitor arterial blood pressure (see **Umbilical artery catheter: insertion and removal** and **Umbilical venous catheter: insertion and removal** guidelines). Check position of lines on X-ray
- Aim to maintain arterial $PaCO_2$ of 6–8 kPa
- Document neurology before commencing sedation or anticonvulsants, including size and reactivity of pupils
- Sedate baby using morphine at an infusion rate of 20 microgram/kg/hr. Aim for heart rate of 100 bpm. Faster rates may be a sign of distress, in which case increase sedation
- Maintain mean arterial blood pressure at >45 mmHg (see **Hypotension** guideline)
- Restrict total fluids to 40 mL/kg/day initially
- Keep glucose within normal range – use higher glucose concentration infusion if necessary (see **Hypoglycaemia** guideline)
- Take blood for blood culture, FBC, arterial blood gas, lactate, electrolytes, urea and creatinine, calcium, magnesium, prothrombin time, APTT, glucose and LFT

SUBSEQUENT MANAGEMENT

Continue with management below if baby not transferred to cooling centre, or in cooling centre without local guideline for active cooling. NOTE that some of the target values are different to those recommended if a baby is being actively cooled

Oxygen

- Avoid hypoxaemia. Maintain PaO_2 10–12 kPa and SpO_2 >94%
- Episodes of hypoxaemia (possibly associated with convulsions) are an indication for IPPV

Carbon dioxide

- Maintain $PaCO_2$ 6.0–8.0 kPa
- Hyperventilation is contraindicated but, if baby spontaneously hyperventilating, mechanical ventilation, with/without paralysis, may be necessary to control $PaCO_2$

Circulatory support

- Maintain mean arterial blood pressure at ≥45 mmHg (see **Hypotension** guideline)
- If cardiac output poor (e.g. poor perfusion: blood pressure is a poor predictor of cardiac output) use inotropes
- Avoid volume replacement unless evidence of hypovolaemia
- Heart rate of 80–100 bpm is normal – a rise in heart rate may indicate distress, hypovolemia, hypotension, seizures or inotropes

Fluid balance and renal function
- Start fluids at 40 mL/kg/day (see **Intravenous fluid therapy** guideline)
- Observe for SIADH and avoid severe hyponatremia (suggested by hypo-osmolar serum with low serum sodium, associated with an inappropriately high urine sodium and osmolality)
- Further fluid restriction if serum sodium falls and weight gain/failure to lose weight
- If in renal failure, follow **Renal failure** guideline
- Observe for accumulation of nephrotoxic drugs

Acidosis
- Will normally correct itself once adequate respiratory and circulatory support provided (correction occasionally required during initial resuscitation)
- Sodium bicarbonate correction is rarely required post resuscitation, and it is better to allow spontaneous correction

Glucose
- Regular blood glucose monitoring
- Target >2.6 mmol/L
- Fluid restriction may require use of higher concentrations of glucose to maintain satisfactory blood glucose
- Avoid hyperglycaemia (>8 mmol/L)

Calcium
- Asphyxiated babies are at increased risk of hypocalcaemia
- Treat with calcium gluconate when serum corrected calcium <1.7 mmol/L or if ionised calcium <0.8 (see **Hypocalcaemia** guideline)
- Maintain serum magnesium (>1 mmol/L)

Seizures
- In muscle-relaxed baby, abrupt changes in blood pressure, SpO_2 and heart rate can indicate seizures
- Consider treating seizures confirmed with aEEG, particularly if associated with physiological disturbance, prolonged (>3 min) or frequent (>3/hr) (see **Seizures** guideline)

Respiratory depression can occur at high doses of anticonvulsants in babies who are not ventilated

- While seizures are common in HIE, unremitting seizure activity should lead to urgent consideration of other causes of epileptic encephalopathy, including consideration of a trial of pyridoxine

Gastrointestinal system
- Give buccal colostrum unless maternal breast milk contraindicated (see **Nutrition and enteral feeding** guideline)
- If no ongoing organ dysfunction or poor perfusion, offer trophic breast milk
- Term babies who suffer a severe asphyxial insult are at risk of developing NEC [see **Necrotising enterocolitis (NEC)** guideline]
- Coagulopathy is physiological during therapeutic hypothermia treatment but only active bleeding needs treatment. Consider correcting coagulation if there is intracranial bleeding due to head trauma at birth

Sedation
- Assess for pain and distress and treat with opiate medication (evidence that distress increases brain injury in neonatal encephalopathy)
- Use analgesia for procedures likely to cause pain and distress (see **Pain assessment and management** guideline)

Rewarming
- Monitor for hypotension, apnoea and seizures
- Continue aEEG – may need to delay or rewarm slowly if seizures emerge
- Maintain normothermia after rewarming using paracetamol and environmental measures if required

Cranial ultrasound
- Within 12 hr to rule out other causes of encephalopathy

- Generalised increase in echogenicity, indistinct sulci and narrow ventricles
- After aged 2–3 days, increased echogenicity of thalami and parenchymal echodensities
- After 1 week, parenchymal cysts, ventriculomegaly and cortical atrophy may develop
- Cerebral Doppler used early, but does not affect management
- relative increase of end-diastolic blood flow velocity compared to peak systolic blood flow velocity (Resistive Index <0.55 in anterior cerebral artery predicts poor outcome – repeat after 24 hr)

MRI head

- Between days 5–15 of life (preferably day 5–7)

PROGNOSIS

- Risk of long-term problems increase with the degree of encephalopathy
- Normal EEG during first 3 days has good prognosis
- Overall risk of death or significant handicap is negligible for mild HIE, 26% for moderate and almost 100% for severe HIE
- Prolonged encephalopathy (e.g. moderate HIE lasting >6 days) also associated with poor outcome
- Persistent oliguria is associated with poor outcome in 90%
- Prognostic factors indicative of worse outcome:
- prolonged duration of ventilation
- prolonged need for anticonvulsants
- time taken to establish oral feeding
- lack of normal background activity on EEG
- areas of altered signal in thalamus, basal ganglia and posterior limb of the internal capsule
- Discuss prognosis with parents before discharge from NICU, document and relay to referring unit

REORIENTATION OF CARE

- When prognosis very poor, discuss withdrawing intensive care support and palliative care
- Very poor prognostic factors include:
- need for prolonged resuscitation at birth
- evidence of severe asphyxia
- multi-organ failure
- intractable seizures
- coma
- very abnormal cranial ultrasound scan and/or MRI
- persistent burst suppression pattern on cerebral function monitoring and/or EEG
- If baby physiologically stable during therapeutic hypothermia, delay consideration of reorientation of care for 48 hr to allow for any recovery before discussions
- Decision to withdraw care requires discussion with parents, and other nursing and medical staff. Such decisions are frequently reached by baby's consultant after a series of discussions
- It helps if the same staff speak to parents on each occasion
- The best interests of the child are paramount
- Record a summary of discussion in notes

DISCHARGE AND FOLLOW-UP

- Arrange clinic follow-up in 4–6 weeks for babies discharged
- Arrange hearing screen (see **Hearing screening** guideline)
- All babies who have been cooled must be offered a standardised neurodevelopmental assessment at aged 2 yr
- Refer to (Maternity & Newborn Safety Investigations) (MNSI) programme https://www.mnsi.org.uk/

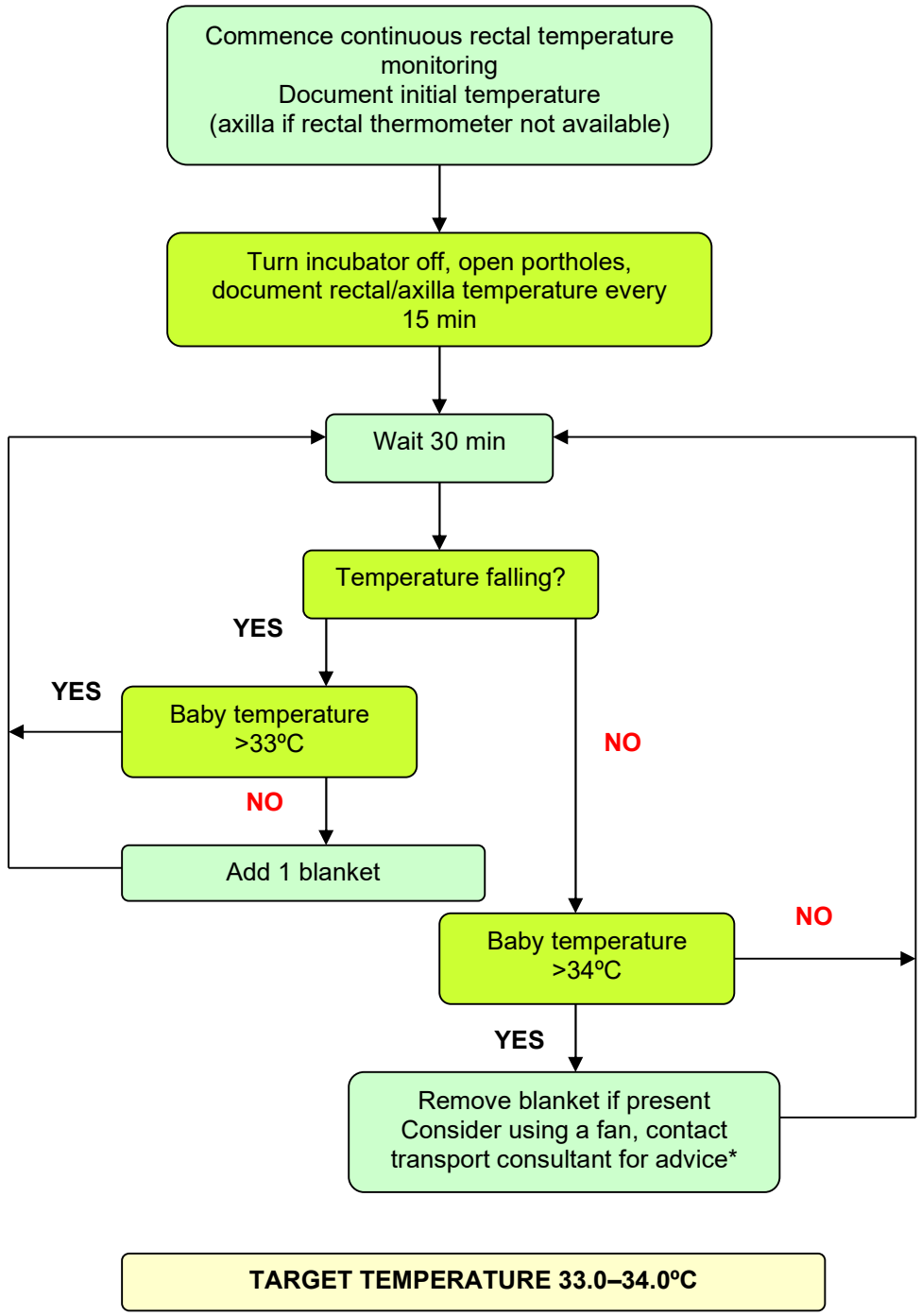
INFORMATION FOR PARENTS

Offer parents information on HIE, available from:

- https://www.bliss.org.uk/parents/about-your-baby/medical-conditions/hypoxic-ischaemic-encephalopathy-hie
- https://www.peeps-hie.org/wp-content/uploads/2022/08/Info-after-NICU.pdf

HYPOXIC ISCHAEMIC ENCEPHALOPATHY (HIE) INCLUDING PREPARATION FOR ACTIVE COOLING ● 6/6

Flowchart: Passive cooling protocol



Do not use ice packs for cooling as severe hypothermia can result

HUMAN IMMUNODEFICIENCY VIRUS (HIV)● 1/3

Vertical transmission of HIV can be prevented only if maternal HIV status known

ANTENATAL

- Check latest version of care plan and last maternal HIV viral load
- If mother is to have zidovudine IV, ensure prescribed antenatally by obstetric team
- Confirm labour ward has antiretrovirals indicated for baby
- Recommend formula feeding; provide bottles/steriliser if necessary
- if mother wishes to breastfeed, refer to HIV team

POSTNATAL

Maternal blood tests

- Check HIV result of every mother
- if no result, recommend mother tested urgently (point of care, if available)
- if declined, offer baby testing (urgent HIV antibody)
- if declined, refer urgently to lead HIV consultant/consultant-on-call

NEONATAL

Very low risk

- 2 weeks' zidovudine monotherapy recommended if all the following criteria met:
- mother has been on combined antiretroviral therapy (cART) >10 weeks **and**
- 2 documented maternal HIV viral loads <50 HIV RNA copies/mL during pregnancy ≥4 weeks apart **and**
- maternal HIV viral load <50 HIV RNA copies/mL at or after 36 weeks

Low risk group

- Extend to 4 weeks' zidovudine monotherapy:
- if criteria for very low risk are not all fulfilled, but maternal HIV viral load <50 HIV RNA copies/mL at or after 36 weeks
- if baby born prematurely (<34 weeks) but most recent maternal HIV viral load <50 HIV RNA copies/mL

High risk group

- Use combination post-exposure prophylaxis (PEP) for 4 weeks:
- if maternal birth HIV viral load known to be or likely to be >50 HIV RNA copies/mL on day of birth
- if uncertainty about recent maternal adherence **or**
- if viral load not known
- If maternal resistance to zidovudine and/or nevirapine and viral load >50 copies/mL, follow individualised plan
- If no maternal resistance to zidovudine and/or nevirapine, or resistance result not immediately available, give baby zidovudine, lamivudine and nevirapine
- If mother diagnosed postpartum, start baby on triple therapy immediately if aged <72 hr

TREATMENT OF BABY

- Do not delay treatment for blood tests or any other reason
- Start as soon as possible after birth, definitely within 4 hr

Table 1: Zidovudine (10 mg/mL) (gestational age at birth) (duration – see above)

<30 weeks and on feeds	2 mg/kg oral/NG 12-hrly
30–34 weeks and on feeds	2 mg/kg oral/NG 12-hrly for first 2 weeks **Then if not very low risk:** 2 mg/kg oral/NG 8-hrly for second 2 weeks
<34 weeks and not tolerating feeds	1.5 mg/kg IV over 30 min 12-hrly Change to 6-hrly at 34 weeks
>34 weeks and feeding	4 mg/kg oral 12-hrly (see **Table 2**)
≥34 weeks and not tolerating feeds	1.5 mg/kg IV over 30 min 6-hrly

Table 2: Oral zidovudine dose at 4 mg/kg by weight

Weight range (kg)	Oral dose (mg) 12-hrly (equivalent to 4 mg/kg)	Volume (mL) to be given oral 12-hrly
2.01–2.12	8.5	0.85
2.13–2.25	9	0.9
2.26–2.37	9.5	0.95
2.38–2.5	10	1
2.51–2.75	11	1.1
2.76–3.00	12	1.2
3.01–3.25	13	1.3
3.26–3.50	14	1.4
3.51–3.75	15	1.5
3.76–4.00	16	1.6
4.01–4.25	17	1.7
4.26–4.50	18	1.8
4.51–4.75	19	1.9
4.76–5.00	20	2

- Lamivudine 2 mg/kg oral 12-hrly for 4 weeks
- Nevirapine 2 mg/kg oral daily for 1 week, then 4 mg/kg daily for 1 week, then stop
  - if mother on nevirapine >3 days, give baby 4 mg/kg daily for 2 weeks then stop
- Round doses **up** to the nearest 0.5 mg to assist administration
- If medication cannot be given orally, give zidovudine IV
  - if high risk, change to zidovudine oral for 4 weeks as soon as medication can be given orally and add lamivudine oral for 4 weeks and nevirapine for 2 weeks
- If maternal viral load <50 copies/mL and previous resistance to zidovudine
  - zidovudine monotherapy is recommended for infant PEP
- If maternal viral load >50 copies/mL and antiretroviral resistance
  - follow individualised care plan
    - if care plan not available discuss with lead consultant for HIV perinatal care
- Advice available (24 hr) from regional hub [e.g. Birmingham Heartlands Hospital (0121 424 2000), North Manchester (0300 330 9444)] or national lead centre in London: St Mary's (0207 886 6666) or St George's (0208 725 3262)

TESTING OF BABY

- HIV viral load (RNA PCR) minimum 2 mL EDTA venous (not cord/heel prick) to be sent to local virology laboratory within first 48 hr and before hospital discharge
- If recommended by HIV specialist also send HIV DNA PCR, (1.3 mL EDTA) to Public Health England at Colindale with paired sample from mother

DISCHARGE AND FOLLOW-UP

- Advise postnatal staff not to recommend breastfeeding
- Contact obstetric team to organise cabergoline for mother to suppress milk
- If mother does breastfeed, monthly HIV viral load testing for mother and baby
  - recommended breastfeeding to be as short as possible (ideally <6 months), then baby to be established on formula milk and solids introduced
  - stop breastfeeding immediately if:
    - maternal HIV viral load detectable
    - nipple infection (mastitis or *Candida*), cracked or bleeding
    - mother or baby has diarrhoea or vomiting
    - ensure supply of formula and bottle feeding equipment on discharge
- If baby vomits within 30 min of taking medicines, or if medicine is seen in the vomit, give the dose again
- Prescribe first dose zidovudine as stat dose, then prescribe twice daily doses at convenient time of day e.g. 9 am and 9 pm (first 2 doses can be given close together without toxicity)
- Dose does not need to be changed with baby's weight change
- Ensure mother confident to give antiretrovirals to baby

- Dispense antiretroviral supply on discharge
- Notify lead for infectious diseases who will notify Integrated Services Outcomes Surveillance Services (ISOSS)
- Follow-up appointment with lead for infectious diseases at 2 weeks for high risk, or 6 weeks for low and very low risk
- Ensure all involved have record of perinatal care: mother, paediatrician, obstetrician, lead for infectious diseases

SUBSEQUENT MANAGEMENT

Investigations

- HIV viral load (RNA PCR) minimum 2 mL EDTA:
- exclusively non-breastfed babies:
  - if high risk at aged 2 weeks
  - all babies at 6 weeks (at least 2 weeks post cessation of infant prophylaxis) **and**
  - at 12 weeks (at least 8 weeks post cessation of infant prophylaxis)
  - on other occasions if additional risk
  - HIV antibody testing at aged 2 yr if laboratory only using combined antibody/antigen test
- Breastfed babies:
- HIV viral load at 2 weeks then every 4 weeks for as long as any breastfeeds, and 1 and 2 months after stopping breastfeeding
- then as above

PCP prophylaxis

- From aged 4 weeks if HIV positive

Immunisations

- Recommend all other vaccinations as per routine schedule (including rotavirus and MMR)
- Do not delay BCG if low or very low risk of HIV transmission and BCG indicated

HYDROPS FETALIS● 1/2

DEFINITION

- Abnormal accumulation of fluid in ≥2 compartments of the fetus (pleural and pericardial effusions, ascites and/or subcutaneous oedema)
- Often associated with polycythaemia and placental thickening
- High but variable mortality rates dependent on underlying cause

TYPES

- Traditionally classified into 2 types:
- non-immune hydrops fetalis occurs in the absence of maternal antibodies; accounts for 90% of fetal hydrops in Western countries
- immune hydrops fetalis occurs when maternal allo-immune antibodies are produced against fetal red cells causing haemolysis; rare since introduction of anti-D immunoglobulins

AETIOLOGY

- Imbalance of fluid movement between fetal intravascular and interstitial spaces
- Multiple causes including cardiac abnormalities (structural or arrhythmias), chromosomal/ genetic, infection, haematological, metabolic and non-cardiac structural anomalies
- No identifiable cause found in 15–31% of babies

ANTENATAL MANAGEMENT

- Hydrops fetalis is diagnosed antenatally via ultrasound
- Refer to fetal medicine team [important as confirmed antenatal diagnosis aids appropriate counselling of families, and further intensive monitoring required throughout pregnancy (discussion of this is beyond the scope of this guideline)]
- Possible antenatal interventions include intra-uterine blood transfusion and in-utero procedures e.g. paracentesis/thoracentesis
- High risk of premature delivery

Refer all antenatally diagnosed hydrops fetalis to a regional fetal medicine centre for further assessment and management

NEONATAL MANAGEMENT

Resuscitation

- Resuscitation and stabilisation can be difficult
- An expert team including a neonatal consultant should be present at delivery
- Manage according to Neonatal Life Support (NLS)

Consider concurrent pleural/ascitic drains to facilitate resuscitation

- In cases of severe anaemia, give urgent Group O RhD negative blood transfusions
- Baby may need further grouped and crossmatched blood transfusions in NNU

Give only CMV negative and irradiated blood

Ventilation

- Ensure adequate oxygenation and ventilation
- May require high frequency oscillatory ventilation [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline] and muscle relaxation
- If pulmonary hypertension present may require nitric oxide (see **Nitric oxide** guideline)

Cardiovascular system

- Use inotropes to support heart and blood pressure
- If intravascular fluid depletion give colloid
- Strict fluid balance
- If severe compromise may require further pleural and ascitic taps
- Immune hydrops may require exchange transfusion. See **Jaundice** and **Exchange transfusion** guidelines

NEONATAL INVESTIGATIONS

- Due to the extensive list of potential causes, direct investigations according to clinical history and presentation
- Initial investigations to consider include:

	Initial investigations	Further investigations to be considered if underlying cause is not ascertained
Haematology	• FBC (including blood film) • Group and direct Coombs test • Maternal Kleihauer test	• Red cell enzyme deficiency (e.g. G6PD deficiency) • Red cell membrane defects (e.g. hereditary spherocytosis) • Haemoglobinopathies (e.g. thalassaemia)
Biochemistry	• Liver function tests including albumin • Urea, creatinine and electrolytes	• If pleural/ascitic tap done – send for fluid MC+S and biochemistry
Cardiac	• ECG to exclude cardiac dysrhythmias • Echocardiography to exclude structural heart defects	
Placenta	• Send to pathologist	
Genetic testing	• Chromosomes • Microarray	• Investigate for congenital metabolic conditions • Non-immune hydrops − discuss whole exome sequencing with genetics team
Infection	• Toxoplasma, rubella, CMV, parvovirus, herpes simplex virus	
Radiology	• Chest X-ray • Abdominal X-ray • Cranial ultrasound scan	• Further investigations to be guided by clinical picture

Even with optimal management, the mortality rate is high. Suggest a post-mortem in the event of a death

HYPERGLYCAEMIA● 1/3

DEFINITION

- There is no established definition of hyperglycaemia. However, treat if:
- 2 blood sugars ≥12 mmol/L on 2 occasions measured ≥2 hr apart **or**
- persistently high blood sugars ≥12 mmol/L with evidence of significant glycosuria (2+ on urine dipstick)

Do not take sample from an infusion line that has glucose running through it

NON-SPECIFIC CLINICAL FEATURES

- Increased urine output due to osmotic diuresis
- Dehydration
- Weight loss
- Feeding difficulty

Risk factors

- Immaturity of pancreatic function (e.g. extremely premature infants and small-for-gestational-age)
- Insulin resistance
- Glucose overload (e.g. equipment failure, administrator error)
- Stress (e.g. infection, pain)
- Side effects of a medication (e.g. glucocorticoid treatment)

MONITORING

- Most blood gas machines provide glucose measurements
- Check blood glucose at least 6–8 hrly in:
- unstable or acutely ill babies [respiratory distress syndrome, septicaemia, necrotising enterocolitis (NEC)]
- Check blood glucose at least once a day in stable babies:
- <32 weeks' gestation for first week
- receiving parenteral nutrition (PN)
- with severe unexpected dehydration or metabolic acidosis
- with poor weight gain while receiving >120 kcal/kg/day

Babies treated with corticosteroids

- Check urine for glycosuria daily
- Check blood glucose if ≥2+ glucose in urine

TREATMENT

- If possible, discontinue or decrease medications that worsen hyperglycaemia (review medications diluted in glucose to see if switch to sodium chloride 0.9% is an option)

Suspected infection/NEC

- Hyperglycaemia in baby with previously stable blood glucose may be an early indicator of infection or NEC
- Assess baby clinically
- After taking appropriate cultures, treat empirically

Fluids

- If blood glucose ≥12 mmol/L, check urine for glycosuria (of ≥2+) and assess clinical hydration and fluid input/output. Check for fluid administration errors
- Calculate amount of glucose baby is receiving (as mg/kg/min) using the formula:

$$\text{Glucose infusion rate (mg/kg/min)} = \frac{\%\ \text{glucose} \times \text{fluid rate (mL/kg/day)}}{144}$$

- If glucose delivery rate >10 mg/kg/min, decrease glucose infusion gradually every 4–6 hr in decrements of 2 mg/kg/min to 6–10 mg/kg/min.
- If on PN, 8–10 mg/kg/min is acceptable
- Reduce glucose concentration before considering restricting fluids

- if reducing aqueous PN, lipids should also be reduced; lipid should not provide >40% of non-protein energy requirements
- in smaller, extremely low birthweight babies, hyperglycaemia may be exacerbated by higher rates of lipid infusion.
- If glycosuria and hyperglycaemia ≥12 mmol/L persists despite an appropriate glucose infusion rate, consider treating with insulin
- Lipid component of PN may contribute to worsening hyperglycaemia. If on PN discuss reducing or stopping lipid temporarily with consultant/pharmacist

Insulin

- Commence insulin therapy at 0.05 units/kg/hr and titrate according to response – see **Administration of Actrapid® insulin (soluble insulin)**
- Target blood glucose while on insulin is 6–8 mmol/L
- Check blood glucose 1 hr from starting and hourly until target reached
- Increase the insulin by increments of 0.05–0.1 units/kg/hr
- Once blood glucose stable, continue to monitor blood glucose 4-hrly
- When a baby is on insulin it is very important to prevent hypoglycaemia – see below

Preventing hypoglycaemia

Blood glucose (mmol/L)	Insulin infusion rate
>8	• Increase infusion rate in steps of 0.05–0.1 units/kg/hr • rate of increase will be dependent on rate of fall in blood glucose
6–8	• Maintain at current rate
>4–<6	• Reduce infusion rate in steps of 0.05–0.1 units/kg/hr to maintain blood glucose >4 mmol/L • rate of reduction will be dependent on rate of fall in blood glucose
≤4	• Stop infusion

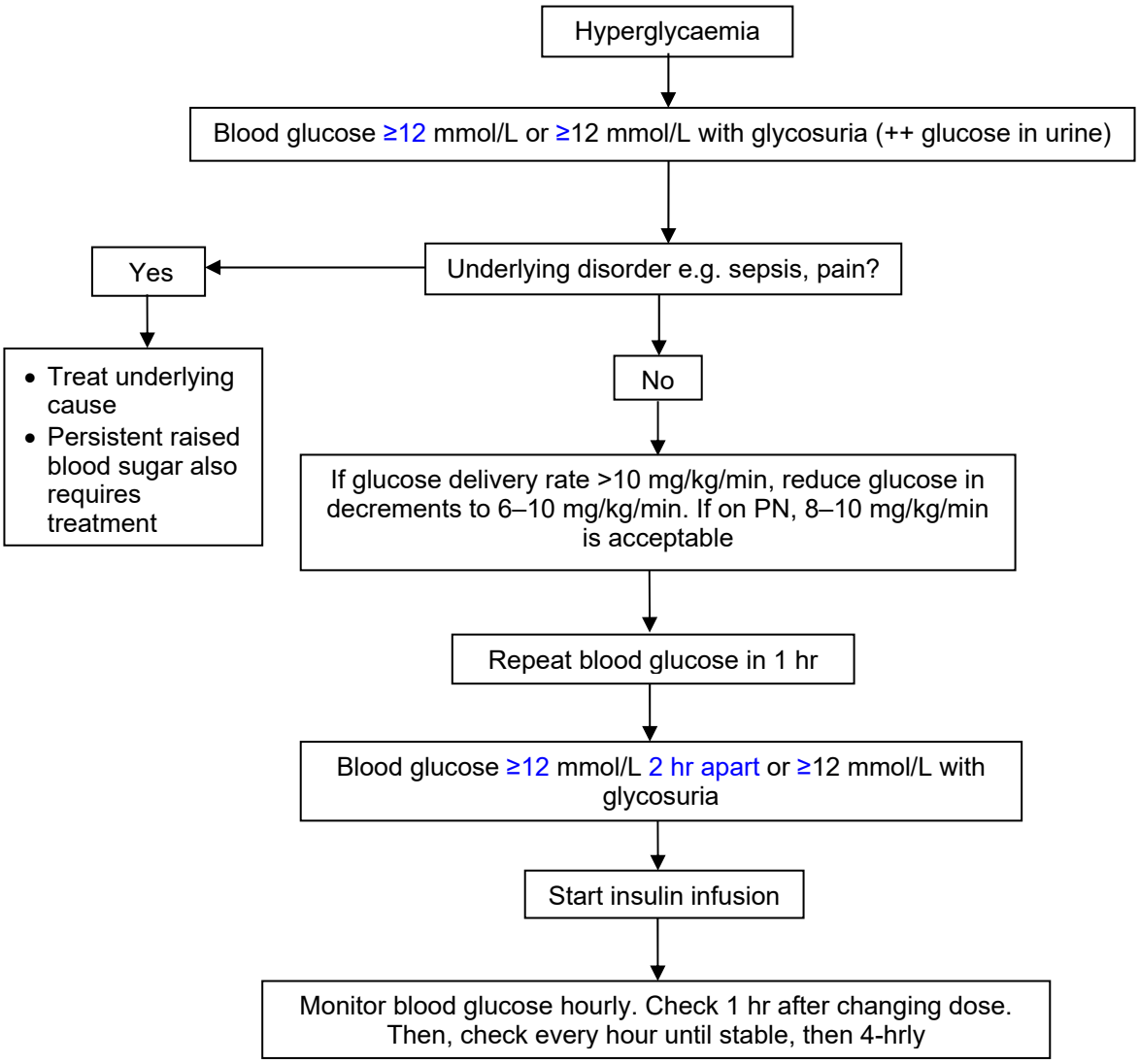
- Recheck blood glucose 1 hr after reducing dose, then 1–2 hrly until stable, then 4-hrly when stable
- If unable to wean off insulin after 1 week, transient neonatal diabetes is possible; consult paediatric endocrinologist
- Early introduction of PN and early trophic enteral feeding will help reduce incidence of hyperglycaemia requiring insulin

ADMINISTRATION OF ACTRAPID® INSULIN (SOLUBLE INSULIN)

- Follow instructions in **Neonatal Formulary** for making up insulin infusion
- dilute Actrapid® insulin 5 units to 50 mL with sodium chloride 0.9 % to give 0.1 units/1 mL. Infusion rate 0.1 mL/kg/hr will give dose 0.01 units/kg/hr
- Administer Actrapid® insulin infusion via a central line or dedicated peripheral cannula
- Before starting infusion, prime all IV connecting and extension sets and T-connectors with insulin infusion fluid. Check manufacturer's guide on lumen capacity for priming volumes (insulin can adhere to the plastic of the syringe)
- Replace insulin infusion every 24 hr

HYPERGLYCAEMIA● 3/3

Summary of neonatal hyperglycaemia management


Hyperglycaemia
Blood glucose ≥12 mmol/L or ≥12 mmol/L with glycosuria (++ glucose in urine)
Underlying disorder e.g. sepsis, pain?
Yes
• Treat underlying cause
• Persistent raised blood sugar also requires treatment
No
If glucose delivery rate >10 mg/kg/min, reduce glucose in decrements to 6–10 mg/kg/min. If on PN, 8–10 mg/kg/min is acceptable
Repeat blood glucose in 1 hr
Blood glucose ≥12 mmol/L 2 hr apart or ≥12 mmol/L with glycosuria
Start insulin infusion
Monitor blood glucose hourly. Check 1 hr after changing dose. Then, check every hour until stable, then 4-hrly

Avoid iatrogenic hypoglycaemia
by careful, regular blood glucose monitoring

HYPERKALAEMIA● 1/4

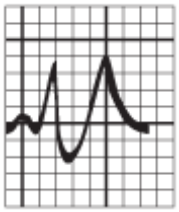
RECOGNITION AND ASSESSMENT

- Plasma potassium >6 mmol/L (normal 3.0–5.5 lithium heparin specimen)
- Babies often tolerate concentrations up to 7.5–8.0 mmol/L without ECG changes

SYMPTOMS AND SIGNS

- Cardiac arrest
- ECG abnormalities (see below):
- tall peaked T waves
- widened QRS complex
- sine waves (widened QRS complex merging with T wave)
- prolonged PR interval, bradycardia, absent P wave
- junctional rhythm
- VT, VF

Tall, peaked T wave, widening of QRS



Sine wave QRS complex (before cardiac arrest)

RISK OF ARRHYTHMIA

- ECG changes as above
- Rapid rise in potassium >7 mmol/L
- Ca^{2+} and Mg^{2+} below normal range
- Oliguria
- Acute kidney injury
- Known cardiac disease

CAUSES

- Renal failure: secondary to hypoxic ischaemic encephalopathy, sepsis and hypotension, post major surgery, structural abnormalities and nephrotoxic drugs
- Cellular injury with potassium release e.g. large intraventricular haemorrhage, haemolysis
- Very-low-birth-weight babies without renal failure (non-oliguric hyperkalaemia) in first 12–48 hr
- Excess potassium in IV solutions, blood transfusions
- Endocrine (congenital adrenal hyperplasia, pseudohypoaldosteronism, Addison's disease, type IV RTA)
- Drugs: suxamethonium, spironolactone

INVESTIGATIONS

- Confirm hyperkalaemia. Send free-flowing venous or arterial laboratory sample to avoid haemolysed sample. Be guided by capillary gas sample in the meantime
- If potassium >6.0 mmol/L, send Ca^{2+}, Mg^{2+}, Cl^{-}, glucose and urinalysis to guide treatment and help identify cause

- If potassium >6.0 mmol/L, commence continuous ECG monitoring and assess for risk of arrhythmia (see above)

IMMEDIATE TREATMENT

Serum potassium >6.0 mmol/L (stable with normal ECG)

- Stop all sources of potassium including IV solutions (check PN), oral supplements and RBC transfusions
- Stop all potassium-retaining drugs and potassium-sparing diuretics e.g. spironolactone
- Avoid suxamethonium
- Review and withhold nephrotoxic drugs e.g. gentamicin
- Recheck U&E 4–6 hrly

Serum potassium >7.0 mmol/L without ECG changes

- As above
- Inform consultant
- Give salbutamol 4 microgram/kg IV in glucose 5% **or** sodium chloride 0.9% over 5–10 min; effect evident within 30 min but sustained benefit may require repeat infusion after at least 2 hr
- Give furosemide 1 mg/kg IV
- If serum potassium still >7.0 mmol/L, give soluble insulin 0.1 units/kg IV in 10 mL/kg 10% glucose over 30 min; very effective and has an additive effect with salbutamol
- Repeat U&E 2–3 hrly
- Repeat insulin infusion as necessary until potassium <7.0 mmol/L
- **Monitor blood glucose every 15 min for first 2 hr during and after infusion**
- aim for blood glucose 4.0–7.0 mmol/L
- Give sodium bicarbonate 1 mmol/kg (sodium bicarbonate 4.2% = 0.5 mmol/mL and sodium bicarbonate 8.4% = 1 mmol/mL, dilute 8.4% solution 1:1 in glucose 5%) over 3 min if:
- pH <7.23 or
- BE more negative than -8 or
- bicarbonate <14 mmol/L
- Correct other electrolyte abnormalities
- Maintain ionised Ca^{2+} >1 mmol/L

Serum potassium >7.5 mmol/L with ECG changes

- As above, but first institute emergency measures below:
- give calcium gluconate 10% 0.5 mL/kg IV/CVL over 5–10 min
  - infuse centrally were possible; does not reduce potassium but stabilises myocardium
  - central access: give neat
  - peripheral access: dilute 1 mL calcium gluconate 10% in 4 mL 0.9% sodium chloride or glucose 5%
- flush line with sodium chloride 0.9% or preferably use a different line
  - always give separately to bicarbonate or PN (calcium gluconate must not come into contact with any other IV administered drug)
- give sodium bicarbonate (1 mmol/kg IV over 2 min). Effective even in babies who are not acidotic (sodium bicarbonate 4.2% = 0.5 mmol/mL and sodium bicarbonate 8.4% = 1 mmol/mL, dilute 8.4% solution 1:1 in glucose 5%)
- Repeat U&E hourly

Further treatments: discuss with consultant

- A cation-exchange resin, such as calcium resonium (500 mg/kg rectally, with removal by colonic irrigation after 8–12 hr, repeat every 12 hr. Dose can be doubled at least once to 1 g/kg in severe hyperkalaemia). Useful for sustained reduction in serum potassium but takes many hours to act and is best avoided **in sick preterms at risk of necrotising enterocolitis**
- If severe hyperkalaemia persists despite above measures in term babies with otherwise good prognosis, contact renal team for consideration of dialysis or exchange transfusion (see **Exchange transfusion** guideline)

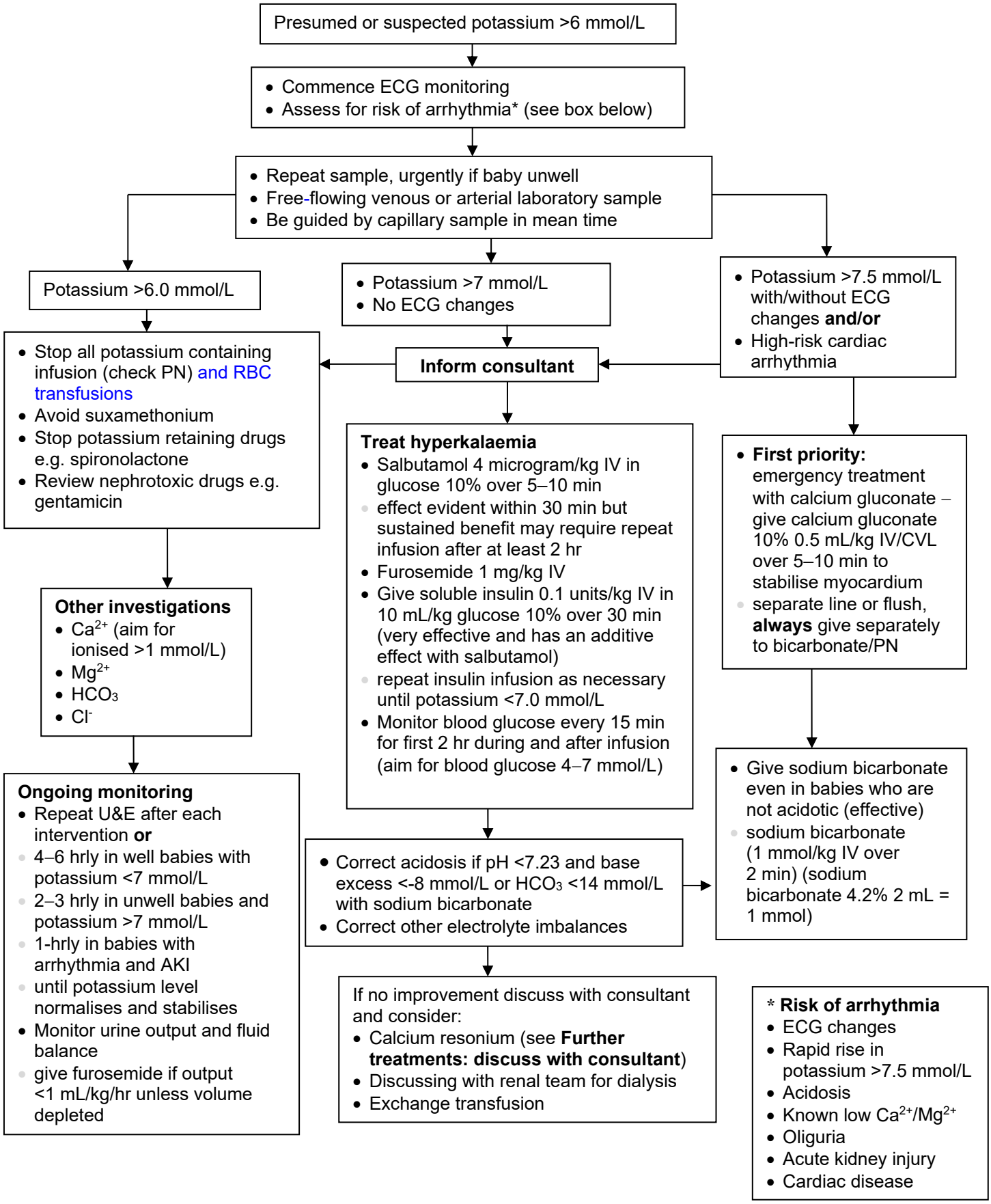
SUBSEQUENT MANAGEMENT

- Recheck serum potassium after each intervention or:
- 4–6 hrly in stable/well baby with potassium <7 mmol/L and no ECG changes
- 2–3 hrly in unwell baby and/or potassium >7 mmol/L with no ECG changes
- hourly when arrhythmias or ECG changes present with/without renal failure
- Monitor urine output and maintain good fluid balance

- If urine output <1 mL/kg/hr, unless baby volume depleted, give furosemide 1 mg/kg IV until volume corrected
- Treat any underlying cause (e.g. renal failure)
- Review need for further investigations for underlying cause e.g. 17OHP for congenital adrenal hyperplasia

HYPERKALAEMIA● 4/4

Flowchart: Management of hyperkalaemia in neonates


Presumed or suspected potassium >6 mmol/L
• Commence ECG monitoring
• Assess for risk of arrhythmia* (see box below)
• Repeat sample, urgently if baby unwell
• Free-flowing venous or arterial laboratory sample
• Be guided by capillary sample in mean time
Potassium >6.0 mmol/L
• Potassium >7 mmol/L
• No ECG changes
• Potassium >7.5 mmol/L with/without ECG changes and/or
• High-risk cardiac arrhythmia
• Stop all potassium containing infusion (check PN) and RBC transfusions
• Avoid suxamethonium
• Stop potassium retaining drugs e.g. spironolactone
• Review nephrotoxic drugs e.g. gentamicin
Inform consultant
Other investigations
• Ca2+ (aim for ionised >1 mmol/L)
• Mg2+
• HCO3
• Cl-
Treat hyperkalaemia
• Salbutamol 4 microgram/kg IV in glucose 10% over 5–10 min
• effect evident within 30 min but sustained benefit may require repeat infusion after at least 2 hr
• Furosemide 1 mg/kg IV
• Give soluble insulin 0.1 units/kg IV in 10 mL/kg glucose 10% over 30 min (very effective and has an additive effect with salbutamol)
• repeat insulin infusion as necessary until potassium <7.0 mmol/L
• Monitor blood glucose every 15 min for first 2 hr during and after infusion (aim for blood glucose 4–7 mmol/L)
• First priority: emergency treatment with calcium gluconate – give calcium gluconate 10% 0.5 mL/kg IV/CVL over 5–10 min to stabilise myocardium
• separate line or flush, always give separately to bicarbonate/PN
Ongoing monitoring
• Repeat U&E after each intervention or
• 4–6 hrly in well babies with potassium <7 mmol/L
• 2–3 hrly in unwell babies and potassium >7 mmol/L
• 1-hrly in babies with arrhythmia and AKI
• until potassium level normalises and stabilises
• Monitor urine output and fluid balance
• give furosemide if output <1 mL/kg/hr unless volume depleted
• Correct acidosis if pH <7.23 and base excess <-8 mmol/L or HCO3 <14 mmol/L with sodium bicarbonate
• Correct other electrolyte imbalances
• Give sodium bicarbonate even in babies who are not acidotic (effective)
• sodium bicarbonate (1 mmol/kg IV over 2 min) (sodium bicarbonate 4.2% 2 mL = 1 mmol)
If no improvement discuss with consultant and consider:
• Calcium resonium (see Further treatments: discuss with consultant)
• Discussing with renal team for dialysis
• Exchange transfusion
* Risk of arrhythmia
• ECG changes
• Rapid rise in potassium >7.5 mmol/L
• Acidosis
• Known low Ca2+/Mg2+
• Oliguria
• Acute kidney injury
• Cardiac disease

HYPERNATRAEMIC DEHYDRATION ● 1/3

DEFINITION

- Serum sodium >145 mmol/L
- mild: 146–149 mmol/L
- moderate: 150–160 mmol/L
- severe: >160 mmol/L

Most common cause is failure to establish adequate oral intake while attempting breastfeeding

CAUSES

Common

- Diarrhoea, vomiting
- Infection
- Poor feeding
- Osmotic diuresis
- Excessive insensible losses in extremely premature babies
- Stoma losses
- Iatrogenic
- excessive sodium bicarbonate/sodium chloride administration
- improperly prepared formula

Less common

- Renal dysplasia
- Obstructive uropathy
- Diuretic phase following acute kidney injury
- Diabetes insipidus (central, nephrogenic)

ASSESSMENT

History

- Gestation at birth – preterm <37 weeks' gestation babies at higher risk of hypernatraemic dehydration

Maternal history

- Primiparous mother
- may require more support with feeding
- Maternal breast characteristics (flat, inverted nipples)
- Maternal health post-delivery – maternal infection can impede feed establishment

Feeding history

- Frequency of feeds: <6 times within 24 hr
- Prolonged feeding: >45 min
- Delayed change from meconium to transitional stools
- Reduced urinary frequency

Medication history

- Diuretic use

Known neonatal medical condition

- Midline brain defect
- Renal disease

Table 1: Expected stool and wet nappies in the first week of life

Day	Wet nappies	Stool
1–2	≥2/day	>1/day
3–4	≥3/day	≥2/day, changing in colour and consistency
5–6	≥5/day	≥2/day, yellow in colour

CLINICAL SIGNS

- Irritability/high pitched cry: unsettled during breastfeeding
- Jaundice
- Weight loss >10%

HYPERNATRAEMIC DEHYDRATION ● 2/3

Severe signs
- Lethargy/altered level of consciousness
- Signs of dehydration (sunken fontanelle, doughy skin, dry mucous membrane and reduced skin turgor) may be absent
- Increased tone
- Hyperreflexia
- Seizures (usually during rehydration)

Investigations
- U&E
- Calcium
- Total bilirubin
- Blood glucose
- CRP
- If clinical concerns of sepsis, blood culture
- Paired urinary and serum electrolytes
- If neurological symptoms observed, cranial imaging

MANAGEMENT
- Treat shock as priority (if present)
- Once circulating volume restored slow reduction in sodium concentration, ≤0.5 mmol/hr
- Severe hypernatremia (>160 mmol/L) is a medical emergency – if not confident discuss management with KIDS NTS team for likely transfer to tertiary care

Mild: 146–149 mmol/L
- Does not require hospital/NNU admission, unless co-existing concerns merit this e.g.:
  - jaundice needing phototherapy
  - infection concerns
- Advise midwife/infant feeding team to support mother to continue to breastfeed and offer supplemental feeds
- Midwife to weigh baby in community as appropriate

Moderate: 150–159 mmol/L
- Admit to hospital/NNU
- Top up feeds:
  - encourage mother to breastfeed
  - top-up feeds with MEBM, or formula if insufficient maternal milk, hospital/NNU admission
  - top-up feeds at 100 mL/kg/day
- Restrict breastfeeding to 20 min/feed
- If concerns with suck and swallow, discuss NGT feeds with middle grade/ANNP
- Monitor blood gas and serum sodium 6–8 hrly
- Monitor blood glucose
- If serum sodium falling >0.5 mmol/L/hr consider reducing top-up volumes
- Weigh baby every 24 hr

Severe: >160 mmol/L
- Admit baby to high dependency or neonatal/paediatric intensive care unit
- Monitor closely for abnormal neurology
  - lethargy
  - irritability
  - jittery
  - hyperreflexia
  - seizures
- If baby shocked give sodium chloride 0.9% 10 mL/kg bolus
- Day appropriate enteral or IV fluids for all babies
- If breastfeeding difficulties continue, discuss NGT feeds with consultant
- If enteral feeds not tolerated discuss IV fluids with consultant
- Maintain strict input and output charts
- Monitor serum sodium levels 6-hrly

HYPERNATRAEMIC DEHYDRATION ● 3/3

- Monitor blood glucose
- **do not** correct hyperglycaemia with insulin – can reduce plasma osmolality rapidly and precipitate cerebral oedema
- If serum sodium levels continue to increase inform consultant on-call and consider discussing with nephrology consultant (Birmingham Children's Hospital)
- Ensure serum sodium levels falling <0.5 mmol/L/hr
- Weigh daily
- Aim to correct hypernatremia over 48–72 hr
- Neurodevelopmental follow-up for all babies with moderate and severe hypernatraemia

HYPERTENSION ● 1/4

RECOGNITION AND ASSESSMENT

- Hypertension (HTN) is rare in neonates, unlike hypotension
- Low-birth-weight (<1500 g) and prematurity (<32 weeks' gestation) have been linked to HTN and other cardiovascular disease later in life
- Normal blood pressure (BP) values increase with increasing weight and postnatal age
- rises by 1–2 mmHg/day in the first week and then 1–2 mmHg/week over the next 6 weeks
- these changes are significant, particularly in preterm babies

DEFINITION

Systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) >95th percentile for gestation and postnatal age

Table 1: BP values beyond 2 weeks of age in babies 26–44 weeks' post-conceptional age

Post conceptual age		50th percentile	95th percentile	99th percentile
26 weeks	SBP	55	72	77
	DBP	30	50	56
	Mean BP	**38**	**57**	**63**
28 weeks	SBP	60	75	80
	DBP	38	50	54
	Mean BP	**45**	**58**	**63**
30 weeks	SBP	65	80	85
	DBP	40	55	60
	Mean BP	**48**	**63**	**68**
32 weeks	SBP	68	83	88
	DBP	40	55	60
	Mean BP	**49**	**64**	**69**
34 weeks	SBP	70	85	90
	DBP	40	55	60
	Mean BP	**50**	**65**	**70**
36 weeks	SBP	72	87	92
	DBP	50	65	70
	Mean BP	**57**	**72**	**77**
38 weeks	SBP	77	92	97
	DBP	50	65	70
	Mean BP	**59**	**74**	**79**
40 weeks	SBP	80	95	100
	DBP	50	65	70
	Mean BP	**60**	**75**	**80**
42 weeks	SBP	85	98	102
	DBP	50	65	70
	Mean BP	**62**	**76**	**81**
44 weeks	SBP	88	105	110
	DBP	50	68	73
	Mean BP	**63**	**80**	**85**

SIGNS

- Asymptomatic
- Respiratory distress
- Increased tone
- Lethargy
- Cyanosis
- Apnoea
- Feeding difficulties
- Congestive heart failure
- Mottling
- Irritability/seizures
- Abdominal distension
- Cardiogenic shock
- Cerebral haemorrhage

MEASURING BLOOD PRESSURE IN NEONATES

Method

- **Invasive:** intra-arterial BP monitoring (umbilical artery, radial artery, posterior tibial artery)
- **Non-invasive:** oscillometric device, doppler flow ultrasonography (most reliable non-invasive method of BP measurement)

Technique

- Cuff length must cover ≥80% length of right upper arm and bladder width should be 60% of circumference (narrow cuffs give falsely raised readings)
- For oscillometric readings, measure BP 1.5 hr after feeds/medical intervention with baby supine or prone
- Place cuff, wait 15 min and note state of baby (awake/asleep). Take 3 readings at 2 min intervals
- Check BP in legs (normally higher) as well as arms. If leg BP < arm BP consider diagnosis of coarctation of the aorta (COA)
- For umbilical arterial catheter (UAC) *in situ*, ensure catheter is free of clots/air bubbles and that transducer is calibrated

Physiological variance

- Transient rise: feeding, sucking, pain (post-surgical babies), agitation, being suctioned, crying (increases SBP 17–25 mmHg) or an upright position
- Physiological rise in BP (increasing weight and postnatal age) in the first few weeks of life
- SBP can be 5 mmHg lower in sleeping babies

HISTORY

- Antenatal history (foetal scans, maternal HTN, TORCH screen, tocolytic non-steroidal anti-inflammatory drugs, maternal drug abuse, e.g. cocaine, heroin)
- Perinatal history (mode of delivery, type of anaesthesia given during delivery, maternal steroids)
- Postnatal history (neonatal drugs e.g. caffeine, steroids, inotropes; umbilical lines, neurological status, BP measurement technique)

EXAMINATION

- Full general examination (check for syndromic facies)
- Systemic examination including checking for murmurs, bruits; femoral pulses in both lower limbs (absent or decreased in COA) and abdomen for palpable renal masses (tumours, polycystic kidneys)

INVESTIGATIONS

- Renal function tests
  - elevated serum creatinine/urea signifies renal insufficiency which may be associated with HTN
- Urinalysis
  - haematuria: obstruction, infection, renal vein thrombosis
  - proteinuria: renal parenchymal disease
- Urine culture
  - exclude pyelonephritis
- Thyroid function tests, cortisol, plasma renin and aldosterone
  - plasma renin elevated in renovascular disease and low in primary hyperaldosteronism
  - renin levels are higher in neonates than children and adults. Elevated plasma renin activity may not always indicate underlying renal disease
  - medication such as caffeine can raise renin levels
- Abdominal ultrasound
  - abdominal masses and renal obstruction
  - Doppler flow ultrasonography can rule out arterial/venous causes (detects renal artery stenosis but can miss branch artery stenosis)
  - if UAC *in situ*, check aorta and renal arteries for thrombi
- Cranial ultrasound
  - intra-ventricular haemorrhage (IVH)
  - cerebral oedema
- Echocardiogram
  - COA
  - signs of end organ damage (left ventricular hypertrophy or decreased contractility)

- Other investigations to consider following discussion with the relevant specialist
  - arteriography – renovascular disease
  - venocavography – renal vein thrombosis
  - CT/MR angiogram – renovascular disease and middle aortic pathology
  - MCUG
  - DMSA
  - serum and urine metanephrines – exclude pheochromocytoma
  - urine 17-hydroxysteroid and 17-ketosteroid levels – Cushing's and CAH
  - gene expression array
  - fundoscopy
  - ECG
  - CXR

DIFFERENTIAL DIAGNOSIS

- Renal parenchymal disease
- Reno-vascular causes
- Pain
- Acquired renal conditions
- Neurological
- Pulmonary
- Cardiovascular causes
- Medication related (maternal and neonatal)
- Endocrine causes
- Idiopathic

TREATMENT

- Determined by severity of HTN, whether baby is symptomatic and presence of end organ damage (e.g. left ventricular hypertrophy, encephalopathy, haematuria, proteinuria, hypertensive retinopathy)
- Treat cause (e.g. correcting fluid overload, treating pain, removing iatrogenic agents that may have contributed to HTN)
- Start each medication at lowest recommended dose
- Monitor BP at least every 15 min in the first 2 hr of treatment and then hourly to avoid hypotension and hypoperfusion
- Surgery may be indicated for the treatment of secondary HTN, e.g. COA, renal artery stenosis HTN, renal vein thrombosis, polycystic kidney disease, tumours or ureteral obstruction to avoid long-term anti-hypertensive medical treatment although, in some cases, this is not guaranteed
- COA: if suspected, discuss with consultant on whether to use prostin (see **Prostaglandin infusion** guideline) in an attempt to reopen the duct
  - if baby ventilated, higher doses can be used safely following discussion with cardiologist
- Treat the following 3 categories of neonates:
  - SBP 95–99th centile and symptomatic or evidence of end organ damage
  - asymptomatic with SBP >99th centile
  - symptomatic with SBP >99th centile (hypertensive crisis)

HYPERTENSIVE CRISIS

- Discuss with renal and cardiac teams
- IV treatment to reduce BP slowly to <90th centile
  - one third total reduction in first 12 hr
  - next one third total reduction in second 12 hr
  - final one third total reduction over next 24 hr
- If BP drops suddenly – fluid bolus and reduce drug dose
- IV drug options include:
  - labetalol
  - hydralazine
  - nicardipine (caution with perinatal asphyxia)
  - if cardiac function poor and no systemic obstruction, milrinone (on advice of paediatric cardiologist)

- **NON HYPERTENSIVE CRISIS**
- Use oral agents, options include:
  - amlodipine oral
  - hydralazine
  - propranolol
- diuretics e.g. furosemide, spironolactone
- ACE inhibitors (captopril at half normal test dose) not usually used due to significant side effect profile (profound hypotension, acute renal failure, delayed renal maturity in preterm babies, neurological complications)

PROGNOSIS

- Depends on aetiology, timing of diagnosis and management (e.g., repaired COA has excellent prognosis but lifelong cardiology follow-up will be required)
- Usually resolves in majority of babies, especially those with UAC complications
- HTN secondary to renal parenchymal disease requires long-term specialist follow-up

HYPOCALCAEMIA ● 1/3

RECOGNITION AND ASSESSMENT

- Term or preterm babies birth weight ≥1500 g: total serum calcium <2 mmol/L or ionised fraction <1.1 mmo/L
- Preterm baby, birth weight <1500 g: total serum calcium <1.75 mmol/L or ionised fraction <1 mmol/L

SIGNS

- Early onset occurs in first 2–3 days of life and is usually asymptomatic
- Late onset develops after first 2–3 days of life and typically occurs at the end of the first week
- Most babies are asymptomatic and identified on screening
- Characteristic sign is increased neuromuscular irritability including:
- jitteriness and irritability
- generalised/focal seizures
- non-specific symptoms e.g.:
  - poor feeding
  - lethargy
  - apnoea
- prolonged QTc on ECG
- rare presentations:
  - stridor
  - bronchospasm
  - pylorospasm

CAUSES

- Early onset:
- prematurity
- intrauterine growth restriction
- infants of diabetic mother
- hypoxic ischaemic encephalopathy
- hypomagnesaemia
- hypoparathyroidism
- syndromes e.g. DiGeorge syndrome
- maternal hyperparathyroidism
- Late onset:
- high phosphate load – cow's milk, renal failure
- hypomagnesaemia
- parenteral nutrition
- exchange transfusion
- alkalosis
- maternal hypercalcemia
- maternal vitamin D deficiency
- transient hypoparathyroidism
- syndromes and genetic mutations e.g. DiGeorge and Kenny-Caffey syndromes

INVESTIGATIONS

- Serum calcium
- only monitor if risk factors, most babies with hypocalcaemia are asymptomatic
- well preterm baby with birth weight >1500 g and well term babies of diabetic mothers receiving milk feedings on day 1 of life do not need testing routinely
- ionised calcium preferred
- if using total calcium, measure albumin and correct for hypoalbuminemia
- Phosphate
- Magnesium
- Persistent hypocalcaemia or severe hypocalcaemia despite adequate calcium therapy:
- 25-hydroxyvitamin D level
- renal function tests
- liver function test
- alkaline phosphatase

- parathyroid hormone level
- urinary calcium:creatinine ratio
- ECG for prolonged QTc interval
- if pseudohyperparathyroidism suspected, X-ray hand
- chest X-ray for thymic shadow
- if hypoparathyroidism suspected, renal ultrasound
- if DiGeorge syndrome suspected, echocardiography
- genetic test for gene mutations or suspected syndrome e.g. DiGeorge syndrome

MANAGEMENT

See **Flowchart: Diagnostic approach to neonatal hypocalcaemia**

Asymptomatic babies

- Most babies with early onset hypocalcaemia recover with nutritional support; so early feeding provides adequate calcium
- Babies requiring IV fluid: add calcium gluconate 10% 0.46 mmol/kg/day (= 2 mL/kg/day) to IV fluid and give as continuous infusion
- baby tolerating oral feeds: give 0.25 mmol/kg oral 6-hrly

Symptomatic hypocalcaemia

- If seizures, prolonged QT interval, apnoea, unstable, hypotension or poor feeding give IV calcium gluconate 10% 0.11 mmol/kg (= 0.5 mL/kg) over 5–10 min followed by maintenance
- dilute with sodium chloride 0.9% or glucose 5% 4 mL to each 1 mL calcium gluconate 10% to give a concentration of 45 micromol/mL. Can be given undiluted via central line in an emergency
- doses up to 0.46 mmol/kg (= 2 mL/kg calcium gluconate 10%) have been used
- **maximum rate of administration** 22 micromol/kg/hr
- Stable baby or following acute treatment
- oral calcium dose 0.25 mmol/kg 6-hrly
- if enteral feeds not tolerated add calcium gluconate 10% 0.5 mmol/kg/day to IV fluid as above
- If symptomatic hypocalcaemia: hypomagnesaemia – magnesium sulphate 100 mg/kg IV/ deep IM 12-hrly for 2–3 doses
- Vitamin D deficiency give 1000–2000 units daily and adjust dose according to response
- Hyperphosphataemia
- high calcium, low phosphate diet
- human milk is preferable, if not available, use formula with low phosphate 60/40 and oral calcium

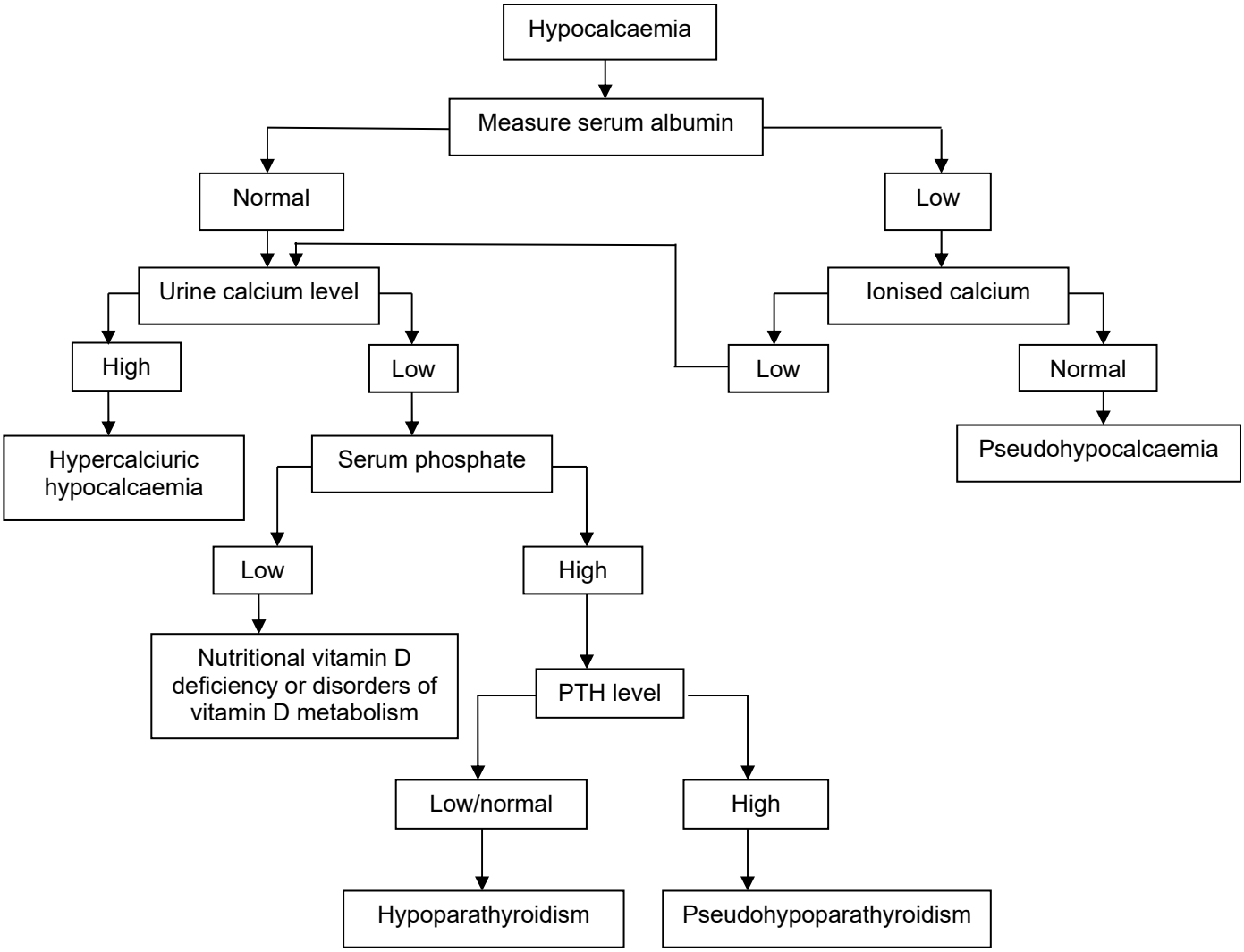
IV calcium precautions and considerations

- Extravasation can cause skin and subcutaneous tissue necrosis (see **Extravasation** guideline). Monitor IV site closely
- Continuous infusion preferred to bolus, but use bolus for initial management in symptomatic hypocalcaemia
- Bolus IV calcium can cause dysrhythmias – administer slowly over 5–10 min with cardiac monitoring
- Calcium can be given via UVC provided catheter tip is in vena cava
- inadvertent administration into portal vein can cause hepatic necrosis
- Do not mix calcium solutions with those containing phosphorus or bicarbonate as this can cause precipitation

SUBSEQUENT MANAGEMENT

- Monitor bone profile and phosphate levels according to clinical need
- If calcium normal after 48 hr treatment, halve maintenance dose
- If calcium fails to normalise investigate for underlying cause
- For extreme preterm babies with late onset hypocalcaemia [see **Metabolic bone disease (MBD)** guideline]
- Hyperphosphataemia – calcium and phosphate normalise in 3–5 days. Stop calcium after 1 week and switch to normal formula in 2–4 weeks

Flowchart: Diagnostic approach to neonatal hypocalcaemia



HYPOGLYCAEMIA (BIRTH–72 HR) ● 1/9

USE GUIDELINE FOR:

- Well babies outside of NNU
- Babies in first 72 hr after birth during the period of metabolic transition
- Babies ≥37 weeks' gestation [guidance based on **Identification and Management of Neonatal Hypoglycaemia in the Full-Term Infant (Birth–72 hours) A Framework for Practice, British Association of Perinatal Medicine January 2024]**

- For babies 34^{+0}–36^{+6} weeks' gestation, this guideline can be used as an **adjuct** to, but **not as a replacement** for **Early Postnatal Care of the Moderate-Late Preterm Infant – A Framework for Practice, British Association of Perinatal Medicine January 2023**
- late preterm babies are 24 times more likely than term babies to develop hypoglycaemia, and require a feeding plan to ensure nutritional needs are met in addition to preventing hypoglycaemia

Do NOT use this guideline for:

- **Unwell babies or babies aged >72 hr**
- BAPM advise to increase acceptable blood glucose threshold to **3.5 mmol/L after 72 hr** after birth in babies >37 weeks' gestation
- no threshold provided by BAPM for babies ≤36 weeks' gestation

INDICATIONS FOR BLOOD GLUCOSE MEASUREMENT

- **All babies with ≥1 risk factor** for hypoglycaemia require blood glucose measurement and management – see flowcharts below
- In addition to these risk factors for hypoglycaemia, measure blood glucose for other clinical indications including:
- presence of ≥1 of the following clinical signs/diagnoses:
  - perinatal acidosis (cord arterial or baby pH <7.1 and base deficit ≥-12 mmol/L)
  - hypothermia (<36.5°C) not attributable to environmental factors
  - suspected/confirmed early neonatal sepsis
  - central cyanosis
  - apnoea
  - altered level of consciousness
  - seizures
  - hypotonia
  - lethargy
  - high pitched cry
- Abnormal feeding behaviour **especially after a period of feeding well:**
- not waking for feeds
- not sucking effectively
- appearing unsettled
- demanding very frequent feeds
- Jitteriness (excessive unprovoked repetitive movements of ≥1 limb) is common and is not by itself an indication to measure blood glucose

RISK FACTORS FOR HYPOGLYCAEMIA

- Born <37 weeks' gestation
- Fetal growth restriction
- birth ≤2nd centile (**Table 1**) or
- clinically wasted (e.g. >2 centiles discrepancy between occipital frontal circumference and weight using age and sex normalised charts)
- Babies of mothers with diabetes
- Babies of mother taking beta blockers in third trimester and/or at time of delivery

Table 1: Second centile weights for boys and girls by week of gestation

Gestational age (weeks)	Weight (kg)	
	Boys	Girls
37	2.10	2.00
38	2.30	2.20
39	2.50	2.45
40	2.65	2.60
41	2.80	2.75
42	2.90	2.85

Flowchart 1: Management of babies at risk of hypoglycaemia (risk factors listed above)

- Commence observations using **BAPM Newborn Early Warning Trigger and Track Framework (NEWTT2)**
- Dry and place baby in skin-to-skin care in a warm, draught free room
- Ensure baby kept warm
- Put hat on baby and cover with warm blanket
- Discuss with parents and provide written information that explains:
  - how to prevent hypoglycaemia
  - why baby needs blood glucose monitoring
  - signs that may indicate hypoglycaemia (see **Box 2**)
- Advise parents to inform member of healthcare team if concerned about baby's wellbeing

≥37 weeks' gestation

- **Ensure baby offered feed within first hour**:
  - encourage and support early breastfeeding within first hour after birth, then offer breast in response to feeding cues as often as possible
  - for mothers who choose to formula feed give 40–60 mL/kg/day within the first hour after birth

<37 weeks' gestation

- Ensure baby fed within first hour
- Baby requires a feeding plan in place
- May require NGT feeding to maintain adequate blood glucose levels
- Refer to **Early Postnatal Care of the Moderate-Late Preterm Infant – A Framework for Practice, British Association of Perinatal Medicine January 2023** for full care recommendations

Check blood glucose before 2nd feed (2–4 hr after birth):
≥37 weeks' gestation: Is blood glucose level ≥2.0 mmol/L?
<37 weeks' gestation: Is blood glucose level ≥2.6 mmol/L?

No → See **Flowchart 2 or Flowchart 3 depending on gestation**

Yes ↓

- Encourage frequent feeding and ensure <3 hr from the start of one feed to the start of the next feed
- Assess need for assisting mother with ongoing help with:
  - feeding
  - hand expression
  - recognition of early feeding cues
  - signs of effective attachment and feeding

≥37 weeks' gestation

- If baby not showing signs of effective feeding:
  - encourage continuous skin-to-skin contact and encourage mother to hand express
  - continue to express 8–10 times in 24 hr until baby feeding effectively
  - if no colostrum available, discuss with mother and supplement with formula milk 40–60 mL/kg/day until colostrum available
- If formula-fed, give 40–60 mL/kg/day per feed 3-hrly over first 24 hr of life

<37 weeks' gestation

- Follow baby's feeding plan and care plan as per **Early Postnatal Care of the Moderate-Late Preterm Infant – A Framework for Practice, British Association of Perinatal Medicine January 2023**
- If uncoordinated and not feeding effectively, may require NGT feeds

No ↑

Check blood glucose level before 3rd feed
≥37 weeks' gestation: Is blood glucose level ≥2.0 mmol/L?

- **Note**: NEWTT2 suggests repeating a set of observations in 1 hr if blood glucose 2.0–2.5 mmol/L excluding blood glucose unless otherwise indicated

<37 weeks' gestation: Is blood glucose level ≥2.6 mmol/L?

Yes ↓

- Continue to support responsive breastfeeding
  - ensure mother understands how to assess effective feeding and escalate concerns

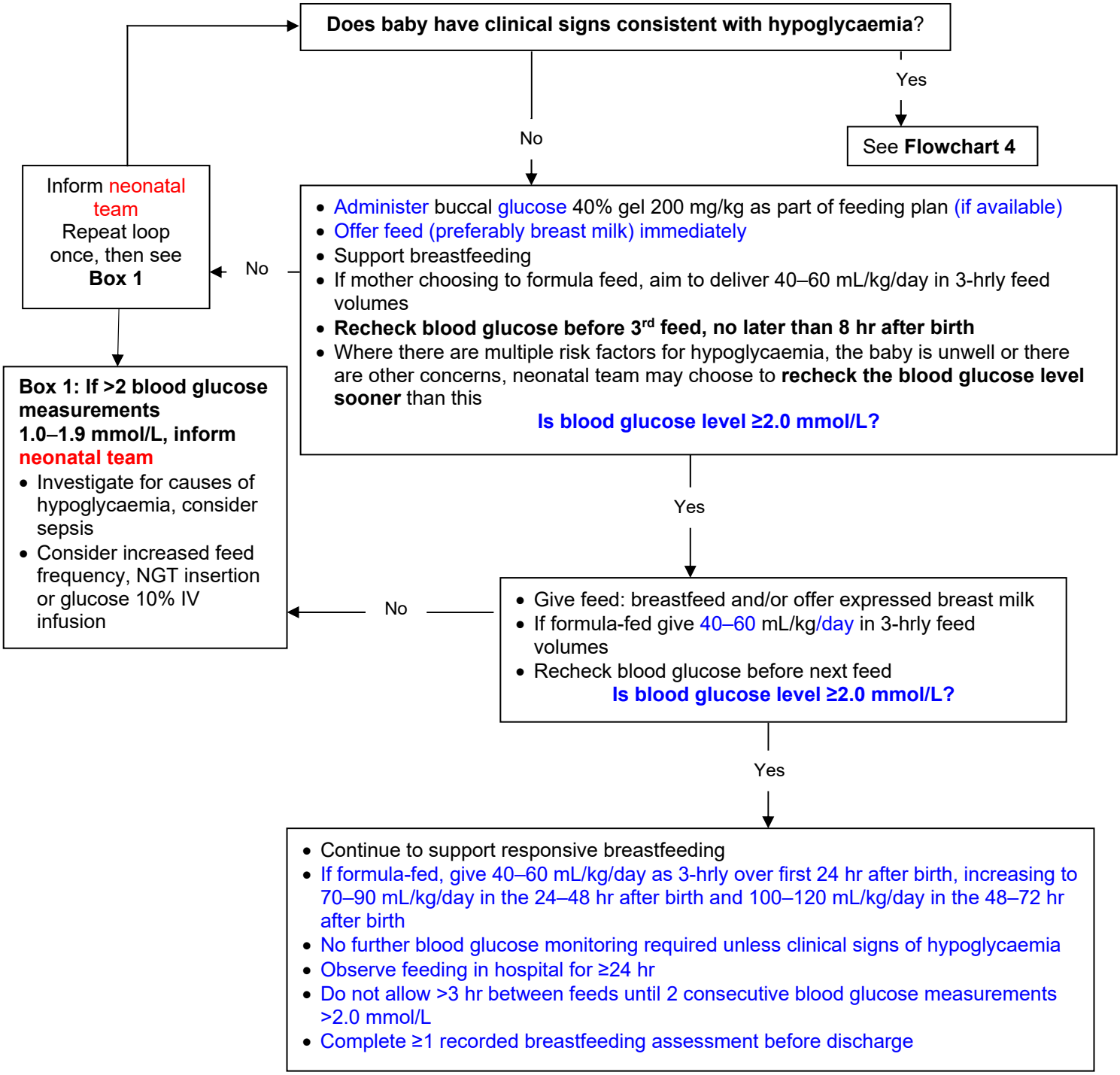
≥37 weeks' gestation

- If formula-fed, give 40–60 mL/kg/day 3-hrly over first 24 hr after birth, increasing to 70–90 mL/kg/day in 24–48 hr after birth, and 100–120 mL/kg/day in first 48–72 hr after birth
- No further blood glucose monitoring required unless clinical signs of hypoglycaemia
- Observe feeding in hospital for ≥24 hr
- Do not allow >3 hr between feeds until 2 consecutive blood glucose measurements >2.0 mmol/L
- Complete at ≥1 recorded breastfeeding assessment before discharge

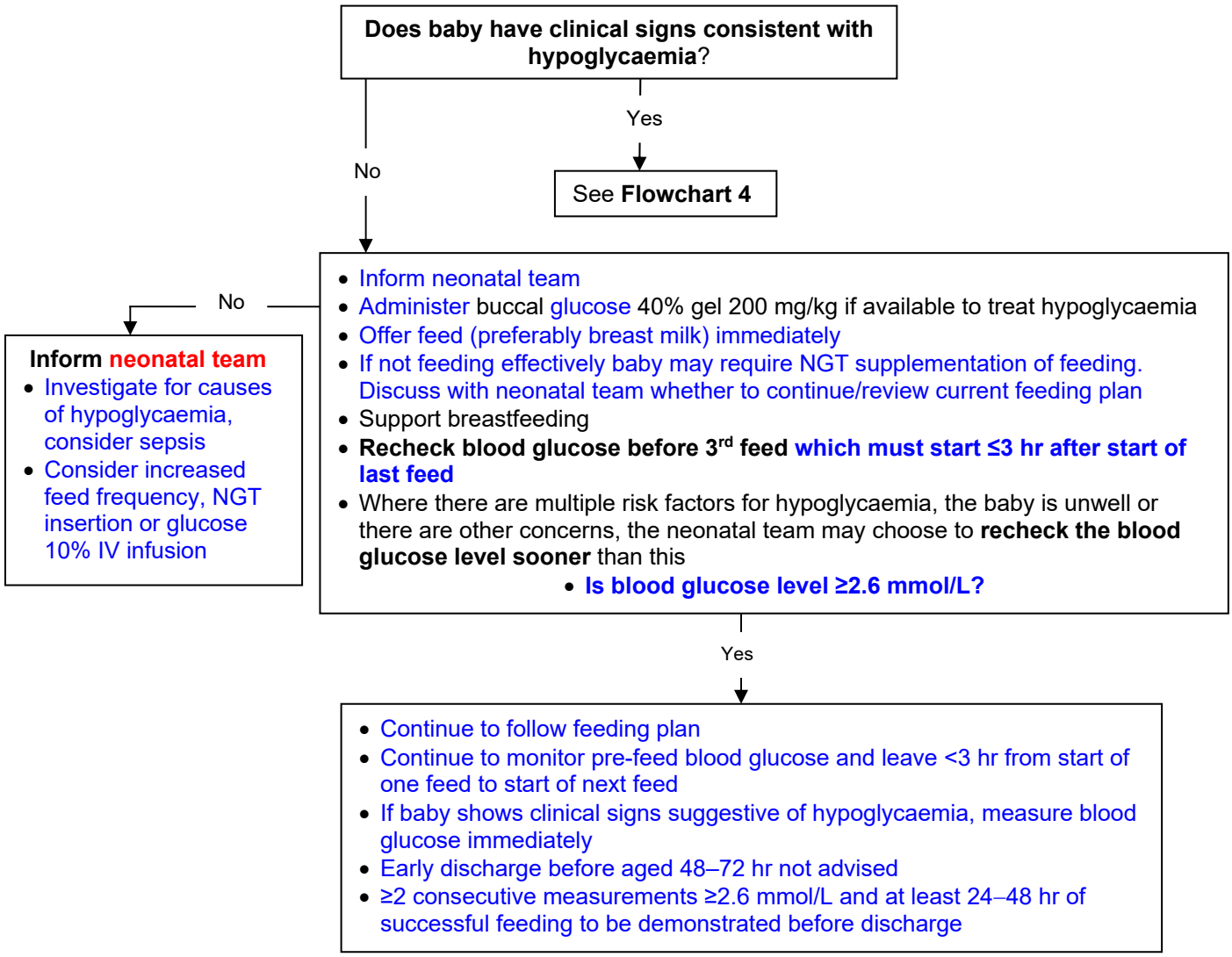
<37 weeks' gestation

- Continue to follow feeding plan
- If baby shows clinical signs suggestive of hypoglycaemia, measure blood glucose immediately
- Early discharge before 48–72 hr not advised.
- ≥2 consecutive measurements ≥2.6 mmol/L and at least 24–48 hr of successful feeding to be demonstrated before discharge

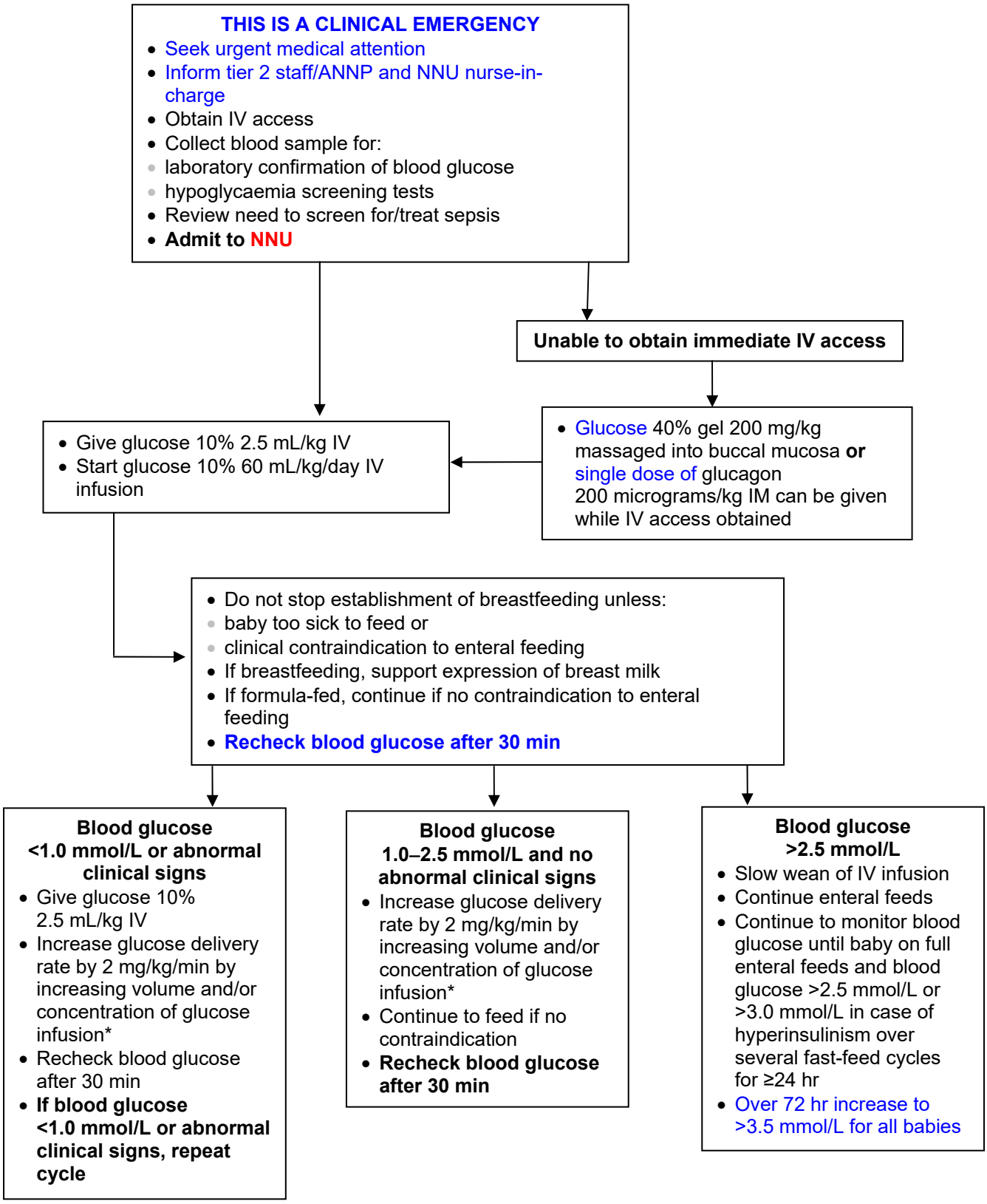
Flowchart 2: ≥37 weeks' gestation with pre-feed blood glucose 1.0–1.9 mmol/L and no abnormal clinical signs


Does baby have clinical signs consistent with hypoglycaemia?
Yes
See Flowchart 4
No
Inform neonatal team
Repeat loop once, then see Box 1
No
• Administer buccal glucose 40% gel 200 mg/kg as part of feeding plan (if available)
• Offer feed (preferably breast milk) immediately
• Support breastfeeding
• If mother choosing to formula feed, aim to deliver 40–60 mL/kg/day in 3-hrly feed volumes
• Recheck blood glucose before 3rd feed, no later than 8 hr after birth
• Where there are multiple risk factors for hypoglycaemia, the baby is unwell or there are other concerns, neonatal team may choose to recheck the blood glucose level sooner than this
Is blood glucose level ≥2.0 mmol/L?
Yes
Box 1: If >2 blood glucose measurements 1.0–1.9 mmol/L, inform neonatal team
• Investigate for causes of hypoglycaemia, consider sepsis
• Consider increased feed frequency, NGT insertion or glucose 10% IV infusion
No
• Give feed: breastfeed and/or offer expressed breast milk
• If formula-fed give 40–60 mL/kg/day in 3-hrly feed volumes
• Recheck blood glucose before next feed
Is blood glucose level ≥2.0 mmol/L?
Yes
• Continue to support responsive breastfeeding
• If formula-fed, give 40–60 mL/kg/day as 3-hrly over first 24 hr after birth, increasing to 70–90 mL/kg/day in the 24–48 hr after birth and 100–120 mL/kg/day in the 48–72 hr after birth
• No further blood glucose monitoring required unless clinical signs of hypoglycaemia
• Observe feeding in hospital for ≥24 hr
• Do not allow >3 hr between feeds until 2 consecutive blood glucose measurements >2.0 mmol/L
• Complete ≥1 recorded breastfeeding assessment before discharge

Flowchart 3: <37 weeks' gestation with pre-feed blood glucose 1.0–2.5 mmol/L and no abnormal clinical signs


Does baby have clinical signs consistent with hypoglycaemia?
Yes
See Flowchart 4
No
Inform neonatal team
Administer buccal glucose 40% gel 200 mg/kg if available to treat hypoglycaemia
Offer feed (preferably breast milk) immediately
If not feeding effectively baby may require NGT supplementation of feeding. Discuss with neonatal team whether to continue/review current feeding plan
Support breastfeeding
Recheck blood glucose before 3rd feed which must start ≤3 hr after start of last feed
Where there are multiple risk factors for hypoglycaemia, the baby is unwell or there are other concerns, the neonatal team may choose to recheck the blood glucose level sooner than this
Is blood glucose level ≥2.6 mmol/L?
No
Inform neonatal team
Investigate for causes of hypoglycaemia, consider sepsis
Consider increased feed frequency, NGT insertion or glucose 10% IV infusion
Yes
Continue to follow feeding plan
Continue to monitor pre-feed blood glucose and leave <3 hr from start of one feed to start of next feed
If baby shows clinical signs suggestive of hypoglycaemia, measure blood glucose immediately
Early discharge before aged 48–72 hr not advised
≥2 consecutive measurements ≥2.6 mmol/L and at least 24–48 hr of successful feeding to be demonstrated before discharge

Flowchart 4: Blood glucose <1.0 mmol/L at any gestation and/or clinical signs consistent with hypoglycaemia


THIS IS A CLINICAL EMERGENCY
• Seek urgent medical attention
• Inform tier 2 staff/ANNP and NNU nurse-in-charge
• Obtain IV access
• Collect blood sample for:
◦ laboratory confirmation of blood glucose
◦ hypoglycaemia screening tests
• Review need to screen for/treat sepsis
• Admit to NNU
Unable to obtain immediate IV access
• Glucose 40% gel 200 mg/kg massaged into buccal mucosa or single dose of glucagon 200 micrograms/kg IM can be given while IV access obtained
• Give glucose 10% 2.5 mL/kg IV
• Start glucose 10% 60 mL/kg/day IV infusion
• Do not stop establishment of breastfeeding unless:
◦ baby too sick to feed or
◦ clinical contraindication to enteral feeding
• If breastfeeding, support expression of breast milk
• If formula-fed, continue if no contraindication to enteral feeding
• Recheck blood glucose after 30 min
Blood glucose <1.0 mmol/L or abnormal clinical signs
• Give glucose 10% 2.5 mL/kg IV
• Increase glucose delivery rate by 2 mg/kg/min by increasing volume and/or concentration of glucose infusion*
• Recheck blood glucose after 30 min
• If blood glucose <1.0 mmol/L or abnormal clinical signs, repeat cycle
Blood glucose 1.0–2.5 mmol/L and no abnormal clinical signs
• Increase glucose delivery rate by 2 mg/kg/min by increasing volume and/or concentration of glucose infusion*
• Continue to feed if no contraindication
• Recheck blood glucose after 30 min
Blood glucose >2.5 mmol/L
• Slow wean of IV infusion
• Continue enteral feeds
• Continue to monitor blood glucose until baby on full enteral feeds and blood glucose >2.5 mmol/L or >3.0 mmol/L in case of hyperinsulinism over several fast-feed cycles for ≥24 hr
• Over 72 hr increase to >3.5 mmol/L for all babies

*** If glucose infusion rate >8 mg/kg/min (see calculation below), test for hyperinsulinism.**

SIGNS THAT MAY INDICATE HYPOGLYCAEMIA

- Lethargy
- Abnormal feeding behaviour especially after a period of feeding well
- High pitched cry
- Altered level of consciousness
- Hypotonia
- Seizures
- Hypothermia (<36.5°C)
- Cyanosis
- Apnoea

SUPPORTING BREASTFEEDING

- Encourage continuous skin-to-skin contact
- Offer breastfeed and if not feeding effectively teach mother to hand express
- Give obtained colostrum to baby by method suitable to parents
- Continue to encourage hand expression ≥8–10 times in 24 hr and support breastfeeding until baby is feeding effectively

BUCCAL GLUCOSE GEL

- Buccal glucose 40% gel 200 mg/kg (0.5 mL/kg of 40% gel) may be used as part of feeding plan in term babies
- use 2.5 or 5 mL oral/enteral syringe
- dry oral mucosa with gauze, gently squirt gel with syringe (no needle) onto inner cheek and massage gel into mucosa using latex-free gloves
- offer a feed (preferably breast milk) immediately
- repeat blood glucose measurement as requested
- if baby remains hypoglycaemic repeat buccal dextrose 40% gel (see **Flowchart 2**)
- if >2 blood glucose measurements 1.0–1.9 mmol/L inform neonatal team to examine and take action as **Box 1**,**Flowchart 2**
- maximum 6 doses in 48 hr
- Continue to support feeding
- Babies <37 weeks' gestation:
- glucose gel may be used to treat hypoglycaemia whilst obtaining IV access – see **Flowchart 4**
- glucose gel only be used as part of feeding plan if advised by neonatal team
- to ensure nutritional needs are met neonatal team may advise
  - increased feed frequency
  - NGT insertion
  - glucose 10% IV
  - see **Flowchart 3**

MEASUREMENT OF BLOOD GLUCOSE

- Accurate measurement of blood glucose level essential for diagnosis and management of neonatal hypoglycaemia
- Ward-based blood gas biosensor (blood gas machine) is the reference standard for measuring blood glucose
- All current cotside devices are prone to inaccuracy, particularly in range 0–2.0 mmol/L
- If handheld glucometer used:
- confirm low values using an accurate method (blood gas analyser or laboratory sample)
- use only devices conforming to ISO 15197:2013 standard
- Blood samples with high PCV can produce erroneously low results

INVESTIGATIONS FOR HYPOGLYCAEMIA

Indications

- Severe hypoglycaemia (<1.0 mmol/L) at any time
- Persistent hypoglycaemia (>2 measurements <2.0 mmol/L ≥37 weeks' gestation or <2.6 mmol/L <37 weeks' gestation within the first 48 hr of life).
- Signs of acute neurological dysfunction and blood glucose <2.5 mmol/L at any time

Investigations

- Review baby to assess if infection screen and treatment required (see **Infection in the first 72 hours of life** guideline)
- Perform following investigations **during** hypoglycaemia

Blood	Urine
Glucose*	Ketones (dipstick)
Lactate*	Urine organic acids
Insulin and C-Peptide*	
Cortisol*	
Free fatty acids	
Ketone bodies	
Acylcarnitine profile	
Plasma amino acids	
Ammonia (venous)	
Growth hormone	

* If insufficient blood obtained during hypoglycaemia prioritise investigations in **bold** (ensure remainder obtained as soon as possible after correcting hypoglycaemia)

- Further investigations as necessary based on results of initial screen and following specialist advice
- for specialist metabolic advice, contact metabolic on-call consultant via Birmingham Children's Hospital switchboard 0121 333 9999
- In a clinically well baby, provided no known risk factors, no abnormal clinical signs and baby feeding well, a one-off episode of transient hypoglycaemia, defined as 1 measurement between 1.0–1.9 mmol/L within the first 48 hr of life, does not require investigation

PERSISTENTLY LOW BLOOD GLUCOSE MEASUREMENT

- Defined as >2 measurements <2.0 mmol/L ≥37 weeks' gestation **or** <2.6 mmol/L <37 weeks' gestation within the first 48 hr of life
- May be the first sign of hyperinsulinism or another metabolic disorder characterised by hypoglycaemia
- If blood glucose concentration remains low (<2.0 mmol/L ≥37 weeks' gestation **or** <2.6 mmol/L <37 weeks' gestation) on ≥3 occasions in the first 48 hr, despite adequate energy provision and a feeding plan, or a glucose dose >8 mg/kg/min (glucose 10% 115 mL/kg/day infusion) is required, suspect hyperinsulinism
- Babies with suspected or confirmed hyperinsulinism may require non-standard glucose infusions to achieve target blood glucose concentration. See below for advice on making up such an infusion
- If hyperinsulism suspected or confirmed, aim to maintain blood glucose >3.0 mmol/L until insulin levels are known
- Hyperinsulinism confirmed if paired insulin and glucose measurements taken whilst hypoglycaemic give glucose:insulin ratio <0.3, or if insulin >10 picomole/L when glucose <2.0 mmol/L
- If baby suspected of having hyperinsulinism discuss with the national centre for hyperinsulinism at Royal Manchester Children's Hospital
- Give glucose ≥12.5% infusion via a central line [see **Umbilical venous catheter insertion and removal** and **Long line insertion (peripherally sited)** guidelines]

Glucose calculations

Calculation of glucose infusion rate

- Glucose infusion rate in mg/kg/min = % glucose × fluid volume in mL/kg/day / 144

IV glucose concentration

Flow rate of glucose 10% (mL/kg/day)	Infusion rate (mg/kg/min)
40	2.77
60	4.16
80	5.55
100	6.94
120	8.33
130	9.03
140	9.72
150	10.42

To make up any concentration of glucose in any volume

- Desired volume = V mL
- Desired concentration of glucose = D%
- Lower concentration of glucose = L%
- Volume of lower concentration of glucose to add = LV mL
- Higher concentration of glucose = H%
- Volume of higher concentration of glucose to add = HV mL

Formula: HV = V (D−L) / (H−L)
LV = V−HV

HV mL + LV mL = V mL of D%

- If ≥12.5% glucose required, give via a central line [see **Umbilical venous catheter insertion and removal** and **Long line insertion (peripherally sited)** guidelines]

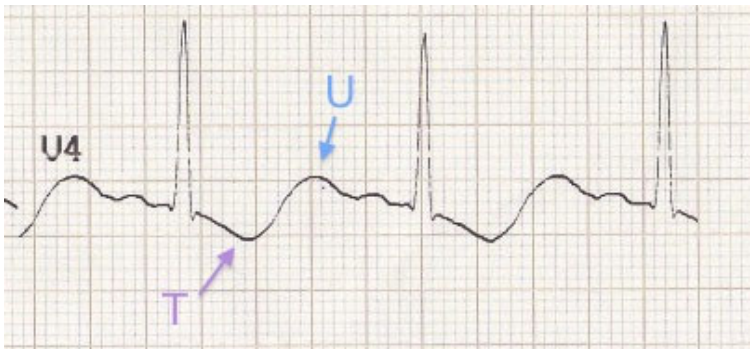
HYPOKALAEMIA● 1/3

DEFINITION

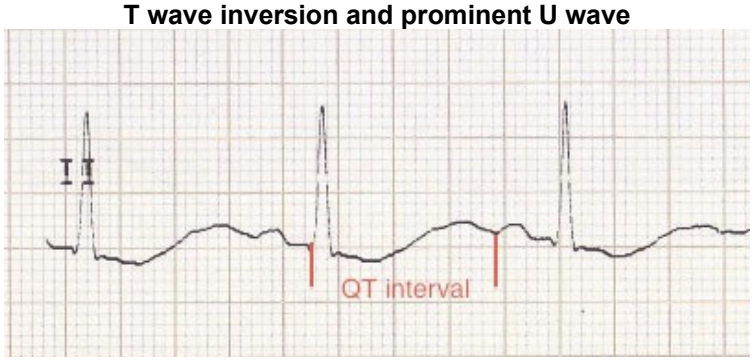
- Plasma potassium level <3.5 mmol/L or below normal level defined by local laboratory
- Symptoms may occur if potassium level <3 mmol/L
- **Note:** low plasma potassium may be a late sign of total body potassium depletion due to mobilisation of intracellular potassium stores

SIGNS

- Muscle weakness and paralysis
- Arrhythmias (premature atrial and ventricular beats, sinus bradycardia, paroxysmal atrial or junctional tachycardia, atrioventricular block, and ventricular tachycardia or fibrillation)
- ECG changes
  - increased amplitude and width of P wave
  - prolongation of PR interval
  - T wave flattening and inversion
  - ST depression
  - prominent U waves (best seen in precordial leads)
  - apparent long QT interval due to fusion of T and U waves



T wave inversion and prominent U wave



Apparently long QT interval (actually T-U fusion)

CAUSES

- Low oral intake/potassium concentration in IV fluids/parenteral nutrition
- Renal loss
  - diuretics
  - bicarbonate administration
  - renal tubular acidosis
  - inherited salt-losing tubulopathies e.g. Bartter Syndrome
- Diarrhoea (**Note**: potassium content of lower GI loss is greater than upper GI loss)
- Alkalosis (approximately 0.4 mmol/L fall in potassium for every 0.1 unit rise in pH)
- Insulin administration
- Refeeding syndrome
- Salbutamol administration (high-dose, nebuliser/IV)
- Liposomal amphotericin (prolonged use)
- Doxapram
- Increased mineralocorticoid activity, due to:
  - hypovolaemia

- 11- beta-hydroxylase deficiency (rarer form of congenital adrenal hyperplasia – presents with virilization, hypertension, and hypokalemia)
- primary hyperaldosteronism

INVESTIGATIONS

- Confirm value on venous laboratory sample (**Note**: 'normal' value on capillary sample may be falsely reassuring if sample has haemolysed and true value is lower)
- ECG
- Cardiac monitor, if ECG changes present
- Mild hypokalaemia (serum level 3–3.5 mmol/L) does not require investigation.
- if hypokalaemia persists or >2 mmol/kg/day maintenance is required – investigate as for significant hypokalaemia (below)
- If significant hypokalaemia (serum level <3 mmol/L) **and** no obvious cause check:
- acid/base balance and bicarbonate level on blood gas
- urinary potassium level. Level >20 mmol/L suggests excess renal potassium losses
- if baby is hypertensive, measure plasma renin and aldosterone
- If hypokalaemia not responding well to replacement, check magnesium level

IMMEDIATE MANAGEMENT

- Supplement feeds/fluids
- normal maintenance potassium requirement is 2 mmol/kg/day
- higher amounts will be needed to correct hypokalaemia
- Review medications
- if baby is on insulin infusion, consider stopping

Symptomatic babies

- Give rapid potassium supplementation
- 'Strong potassium' solution – use with caution/discuss with consultant
- contains 20 mmol/10 mL
- must be **diluted at least 50-fold** with sodium chloride 0.9% or a mixture of sodium chloride 0.9% in glucose before administration
- maximal peripheral concentration 40 mmol/L (1 mmol in 25 mL)
- maximal central concentration 80 mmol/L (1 mmol in 12.5 mL)
- rate 0.2 mmol/kg/hr (maximum 0.5 mmol/kg/hr if severe potassium depletion)
- Continuous cardiac monitoring necessary
- Recheck potassium 2−4 hr and assess need for continuing infusion

Asymptomatic babies

- Potassium replacement given according to how baby is being fed:
- orally fed babies
  - oral supplement e.g. potassium chloride 1 mmol/kg 12-hrly. Titrate dose according to response
- babies on IV fluids
  - add potassium chloride 3−5 mmol/kg/day to IV fluid, depending on electrolyte levels and titrate according to response
- babies receiving parenteral nutrition (PN)
  - increase potassium content of the PN to 3–5 mmol/kg/day
  - if modified PN not available, run separate potassium infusion 3–5 mmol/kg/day alongside current PN

SUBSEQUENT MANAGEMENT

- Monitor potassium levels according to clinical need:
- well babies receiving oral potassium check level once to twice weekly
- well babies on IV fluids or PN with mild hypokalaemia (potassium 3–3.5 mmol/L) check level daily
- check more frequently if:
  - significant hypokalaemia (serum level <3 mmol/L)
  - symptomatic hypokalaemia
  - concentrations of potassium >5 mmol/kg/day are being given
- Once plasma/serum potassium level is in normal range, continue potassium supplementation to allow replenishment of total body potassium (intracellular) stores:

HYPOKALAEMIA● 3/3

- orally fed – continue for a further week
- IV fluids/PN − reduce potassium to 2 mmol/kg/day as maintenance
- recheck potassium level following these changes to ensure hypokalaemia does not recur

HYPOTENSION: HAEMODYNAMIC COMPROMISE ● 1/9

DEFINITION

- Characterised by low blood flow state, that clinically present with ≥1 of the following:
  - low blood pressure
  - acidosis
  - raised lactate
  - reduced urine output
  - tachycardia
  - prolonged capillary refill
  - hypoxaemia
- **Do not** use mean blood pressure as sole indicator of haemodynamic compromise/treatment target
- Use gestational age based systolic and diastolic blood pressure centiles to guide management. See **Table 2** and **Table 3** for blood pressure values by gestational age or use blood pressure calculator https://neopeds.academy/bp/

RECOGNITION AND ASSESSMENT

- If signs of low blood flow state carry out thorough clinical evaluation
  - if possible perform targeted neonatal echocardiography (TnECHO)
- Aim of evaluation, to establish underlying pathophysiology to help direct targeted management

CLINICAL INDICATORS OF COMPROMISED HAEMODYNAMIC STATUS

Table 1

Clinical indicator	Pathophysiology	Comments
Tachycardia	Increasing heart rate may increase cardiac output if stroke volume unchanged	• Affected by medications, pain, temperature, agitation • Avoid chronotropic agents to avoid compromising diastolic function
Systolic hypotension/narrow pulse pressure	Marker of decreased cardiac output	• Affected by transitional circulation, left-to-right shunts • Consider inotropes to augment myocardial contractility
Diastolic hypotension	Marker of systemic vascular resistance (SVR) and preload	• Affected by transitional circulation, left-to-right shunts • Consider vasopressors
Capillary refill time	Vasoconstriction of skin	• Affected by lighting, temperature, skin tone, anaemia
Pallor/acrocyanosis	Vasoconstriction of skin	• Affected by factors such as hypothermia, may be brisk in warm shock
Decreased level of consciousness	Decreased cerebral perfusion pressure	• Affected by sedative medications, meningitis, seizures
Elevated lactate	Anaerobic metabolism	• Also seen in some metabolic disorders, haemolysis, gluconeogenesis, placental insufficiency
Metabolic acidosis	Anaerobic metabolism	• Bicarbonate loss

GENERAL CONSIDERATIONS

HYPOTENSION: HAEMODYNAMIC COMPROMISE ● 2/9

- Tackle iatrogenic causes of low blood flow states in all cases, e.g. high mean airway pressure and over-ventilation
- Non-invasive blood pressure monitoring
  - use appropriately sized blood pressure cuffs
  - if not in keeping with clinical picture, consider repeating readings in different limb
- Invasive BP monitoring, ensure:
  - transducer zeroed and set at appropriate height
  - trace regular and not dampened
  - no air bubbles in line (may be necessary to flush line)
- Optimise ionised calcium to ensure adequate myocardial function
- Do not initiate treatment based on a single marker of hemodynamic compromise
- Consider other causes, e.g.:
  - pneumothorax
  - pericardial effusion
  - lung hyperinflation
  - drug-induced compromise, e.g., opiates
  - congenital heart disease
  - metabolic and endocrine disorders
- Ensure adequate inotrope delivery before switching to a different agent (line patency, line dead-space etc.)
- Further management guided by underlying pathophysiology (see below)

HYPOTENSION: HAEMODYNAMIC COMPROMISE
● 3/9

Table 1 Normal blood pressure values by gestational age for day one (early)
(Mean +/- 95th CI for highest and lowest values)

Gestational age	Systolic			Diastolic			Mean (calculated)			Pulse pressure		
Weeks	95th	50th	5th	95th	50th	5th	95th	50th	5th	95th	50th	5th
22	55	39	22	31	23	14	39	28	17	18	12	8
23	56	40	23	32	24	15	40	29	18	18	12	8
24	57	42	25	33	25	16	41	31	19	18	12	8
25	58	43	26	34	26	17	42	32	20	18	12	8
26	60	44	27	35	27	18	43	33	21	18	12	8
27	61	45	29	36	28	19	44	34	22	18	12	8
28	63	47	31	37	29	20	46	35	24	19	13	9
29	64	48	33	38	30	21	47	36	25	19	13	9
30	66	50	35	39	31	22	48	37	26	19	13	9
31	68	51	36	40	32	23	49	38	27	20	14	10
32	69	52	37	41	33	24	50	39	28	20	14	10
33	70	53	38	42	34	25	51	40	29	20	14	10
34	71	55	40	43	35	26	52	42	31	20	14	10
35	73	57	41	44	36	27	54	43	32	20	14	10
36	75	59	42	45	37	28	55	44	33	20	14	10
37	76	60	44	46	38	29	56	45	34	20	14	10
38	77	61	46	47	39	30	57	46	35	21	15	12
39	79	62	47	48	40	31	58	47	36	21	15	12
40	81	64	48	49	41	32	60	49	37	21	15	12
41	82	65	50	50	42	33	61	50	39	22	15	12
42	84	67	51	51	43	34	62	51	40	22	15	12

Zubrow et al. Philadelphia Neonatal Blood Pressure Study Group. p. J of perinatology 1995

HYPOTENSION: HAEMODYNAMIC COMPROMISE
• 4/9

Table 2: Normal blood pressure values by corrected post conceptional age (Mean +/- 95th CI for highest and lowest values)

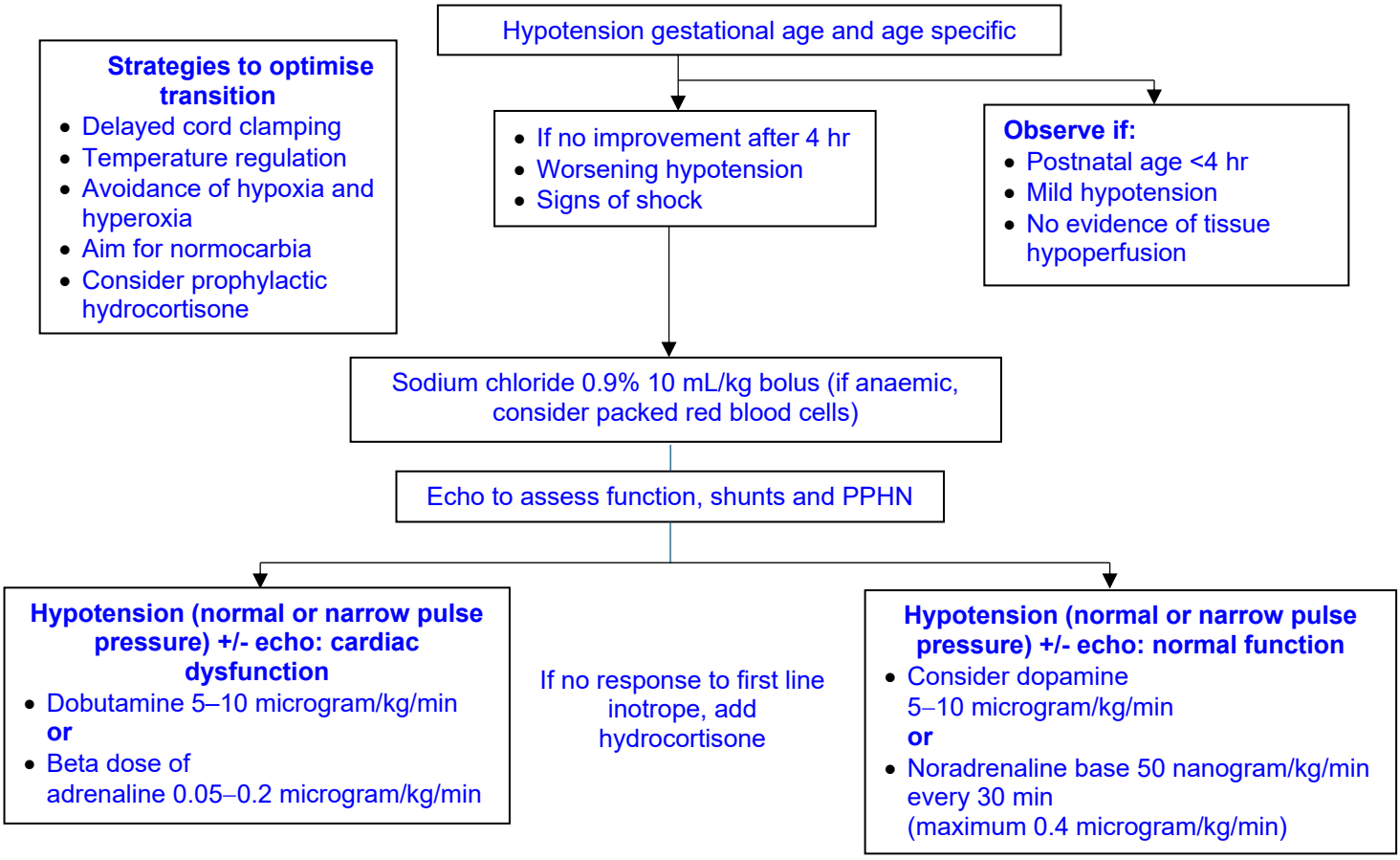
Age	Systolic			Diastolic			Mean (calculated)			Pulse pressure (calculated)		
Weeks	95th	50th	5th	95th	50th	5th	95th	50th	5th	95th	50th	5th
24	68	49	33	46	29	14	53	36	20	25	16	12
25	69	51	36	47	30	15	54	37	22	25	16	12
26	70	52	38	48	31	17	55	38	24	25	16	14
27	71	54	40	49	32	18	56	39	25	25	16	14
28	72	55	41	50	33	19	57	40	26	27	17	15
29	73	56	42	51	34	20	58	41	27	27	17	15
30	75	59	43	52	35	21	60	43	28	28	18	15
31	78	61	46	53	36	22	61	44	30	28	20	17
32	80	62	48	54	37	23	63	45	31	28	20	17
33	81	63	50	55	38	24	64	46	33	28	20	17
34	83	66	51	56	39	25	65	48	34	30	21	18
35	84	69	52	57	40	26	66	50	35	30	21	18
36	87	71	55	58	41	27	68	51	36	30	22	18
37	89	72	57	59	42	28	69	52	38	30	22	18
38	90	75	59	60	43	29	70	54	39	30	22	18
39	91	78	60	60	44	30	70	55	40	30	22	18
40	92	80	61	61	44	30	71	56	40	33	25	20
41	93	81	62	62	46	31	72	58	41	33	25	20
42	95	82	63	63	47	32	74	59	42	33	25	20
43	97	83	65	64	48	33	75	60	44	33	25	20
44	98	86	67	65	49	34	76	61	45	33	25	20
45	100	88	69	66	50	35	77	63	46	33	25	20
46	102	89	71	66	51	36	78	64	48	33	25	21

Zubrow et al. Philadelphia Neonatal Blood Pressure Study Group. p. J of perinatology 1995

TRANSITIONAL HAEMODYNAMIC COMPROMISE IN PRETERM BABIES

- Transitional haemodynamic compromise (33% of babies born <27 weeks) generally characterised by low diastolic BP (<3rd centile), with normal or borderline low systolic BP, leading to low mean BP
- Condition is diagnosis of exclusion, rule out other causes, e.g. sepsis, if no response to first line agents

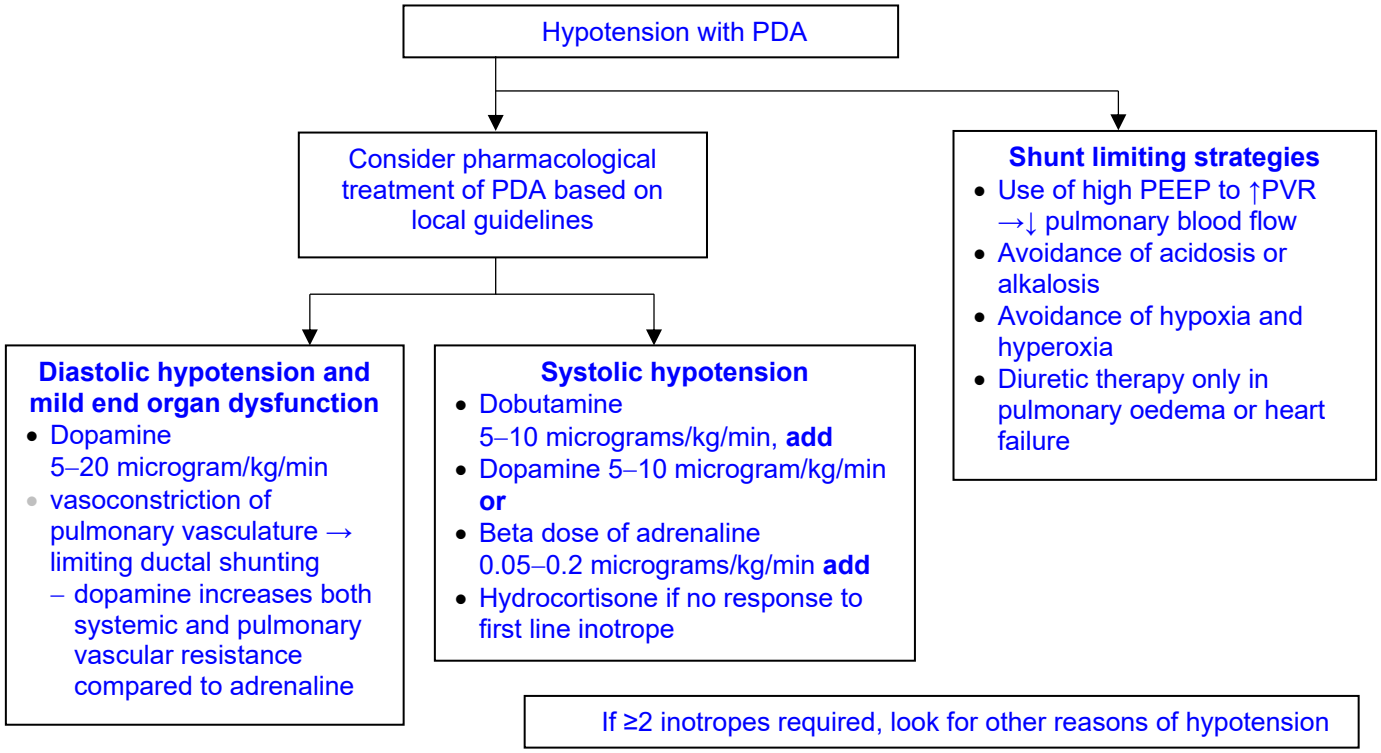
Flowchart: Management of transitional circulatory compromise in preterm babies


Hypotension gestational age and age specific
Strategies to optimise transition
Delayed cord clamping
Temperature regulation
Avoidance of hypoxia and hyperoxia
Aim for normocarbia
Consider prophylactic hydrocortisone
If no improvement after 4 hr
Worsening hypotension
Signs of shock
Observe if:
Postnatal age <4 hr
Mild hypotension
No evidence of tissue hypoperfusion
Sodium chloride 0.9% 10 mL/kg bolus (if anaemic, consider packed red blood cells)
Echo to assess function, shunts and PPHN
Hypotension (normal or narrow pulse pressure) +/- echo: cardiac dysfunction
Dobutamine 5–10 microgram/kg/min
or
Beta dose of adrenaline 0.05–0.2 microgram/kg/min
If no response to first line inotrope, add hydrocortisone
Hypotension (normal or narrow pulse pressure) +/- echo: normal function
Consider dopamine 5–10 microgram/kg/min
or
Noradrenaline base 50 nanogram/kg/min every 30 min (maximum 0.4 microgram/kg/min)

HAEMODYNAMIC COMPROMISE IN PDA

- Haemodynamically significant PDA can result in haemodynamic compromise after transitional period
- As pulmonary vascular resistance falls, transductal shunt volume increases leading to systemic steal and pulmonary over circulation
- Left ventricular (LV) stroke volume increases in response to increase preload
- classically presents as normal to high systolic BP with low diastolic BP (and wide pulse pressure) with/without signs of end organ dysfunction, e.g. acute kidney injury (AKI)
- Inability of the LV to augment systolic performance in response to increased preload will result in systolic hypotension and left atrial hypertension leading to pulmonary venous congestion
- Echocardiography essential to assess PDA and cardiac function
- Unusual for PDA to cause severe hypotension
- if more than first line agents required, look for other causes

Flowchart: Management of hypotension with PDA


Hypotension with PDA
Consider pharmacological treatment of PDA based on local guidelines
Shunt limiting strategies
• Use of high PEEP to ↑PVR →↓ pulmonary blood flow
• Avoidance of acidosis or alkalosis
• Avoidance of hypoxia and hyperoxia
• Diuretic therapy only in pulmonary oedema or heart failure
Diastolic hypotension and mild end organ dysfunction
• Dopamine 5–20 microgram/kg/min
• vasoconstriction of pulmonary vasculature → limiting ductal shunting
– dopamine increases both systemic and pulmonary vascular resistance compared to adrenaline
Systolic hypotension
• Dobutamine 5–10 micrograms/kg/min, add
• Dopamine 5–10 microgram/kg/min or
• Beta dose of adrenaline 0.05–0.2 micrograms/kg/min add
• Hydrocortisone if no response to first line inotrope
If ≥2 inotropes required, look for other reasons of hypotension

HAEMODYNAMIC COMPROMISE IN HYPOXIC ISCHAEMIC INJURY (HIE)

Recognition and assessment

- Perinatal hypoxia results in transient myocardial ischaemia in about one-third of patients, which may result in reduced LV systolic performance and output
- Therapeutic hypothermia may mask hypotension by causing vasoconstriction and increasing diastolic BP
- HIE often associated with comorbidities, e.g. pulmonary hypertension and adrenal injury – may affect cardiovascular stability
- Presence of multiorgan dysfunction and therapeutic hypothermia makes assessment of haemodynamic status challenging due to deranged biochemical and clinical markers
- Echocardiography recommended to assess filling, LV, and right ventricular (RV) function, aPHN, PDA
- See **Recognition and assessment** and **General considerations** above

Management

- Avoid fluid bolus – will worsen cardiac dysfunction and may exacerbate cerebral oedema
  - use fluid bolus only if evidence of intravascular depletion – up to 10 mL/kg over 30 min
- Isolated hypotension without impaired oxygenation
  - start dobutamine 5 microgram/kg/min and titrate up to 10 microgram/kg/min
    - dose >10 microgram/kg/min associated with tachycardia
    - beta dose of adrenaline can be used
- In HIE complicated by pulmonary hypertension (aPHN), see **Pulmonary hypertension** guidelines)
- Isolated hypoxia and aPHN, optimise ventilation and start iNO
- Hypotension (normal pulse pressure) with hypoxia, commence dobutamine **or** beta dose of adrenaline
  - if no response noradrenaline can be added
- Hypotension (wide pulse pressure) with hypoxia in presence of normal echo
  - start noradrenaline base at 0.05 microgram/kg/min and titrate up to 0.4 microgram/kg/min
  - vasopressin can be used cautiously as second line
- If restrictive PDA, start prostin either to support systemic circulation or offload right ventricle
- If no response to first line inotropes, add hydrocortisone.

Flowchart: Approach to haemodynamic optimisation in neonates with HIE

HYPOTENSION: HAEMODYNAMIC COMPROMISE ● 7/9

Monitoring
- Invasive BP recommended
- Monitor blood gas, lactate as indicated
- If vasopressin used, U&Es and urine output 4–6 hrly

- Assess BP, heart rate, capillary refill time, urinary output and continuous pre- and post-ductal saturations
- BP (systolic, diastolic and mean) target >3rd centile for GA
- Echocardiography recommended to assess filling, aPHN, LV and RV function

Hypotension +/- clinical evidence of aPHN
- Dobutamine 5–10 microgram/kg/min +/- beta dose adrenaline

No echo

Normal BP + impaired oxygenation
Echo: normal cardiac function +aPHN
- Optimise lung recruitment + iNO

- Caution with vasopression in HIE, due to hyponatraemia
- Avoid vasopressin in LV dysfunction

Impaired haemodynamics (hypotension +/- aPHN)

Low BP + normal oxygenation
Echo: biventricular dysfunction

First line
- Dobutamine: 5 microgram/kg/min, increase by 5 microgram/kg/min every 30 min

Second line
- Beta dose adrenaline 0.05 microgram/kg/min
- Increase by 0.01–0.02 microgram/kg/min every 30–60 min (max 0.2 microgram/kg/min)
- If no response to first line inotrope add hydrocortisone 2.5 mg/kg 6-hrly

Low BP (normal pulse pressure) + impaired oxygenation
Echo: biventricular dysfunction + aPHN

First line
- Dobutamine: 5 microgram/kg/min, increase by 5 microgram/kg/min every 30 min + iNO

Second line
- Beta dose adrenaline 0.05 microgram/kg/min
- Increase by 0.01–0.02 microgram/kg/min every 30–60 min (max 0.2 microgram/kg/min) **and**
- Noradrenaline base 0.05 microgram/kg/min increase by 0.05 microgram/kg/min every 30 min **and**
- If PDA closing start prostin to support systemic circulation
- If no response to first line inotrope **add** hydrocortisone 2.5 mg/kg every 6 hr

Low BP (↑ pulse pressure) + impaired oxygenation
Echo: good biventricular function

First line
- Noradrenaline base 0.05 microgram/kg/min increase by 0.05 microgram/kg/min every 30 min

Second line
- Vasopressin 0.0003 units/kg/min, increase by 0.0001–0.0003 units/kg/min every 30 min (max 0.002 units/kg/min)

Low BP + impaired oxygenation
Echo: RV dysfunction + aPHN

First line
- Dobutamine 5 microgram/kg/min, increase by 5 microgram/kg/min every 30 min + iNO
- If PDA restrictive, prostin to offload RV

Second line
- Adrenaline 0.05 microgram/kg/min, increase by 0.01–0.02 microgram/kg/min every 30–60 min (max 0.2 microgram/kg/min)

Third line
- Noradrenaline/vasopressin

HAEMODYNAMIC OPTIMISATION IN LATE ONSET SEPSIS/NECROTISING ENTEROCOLITIS (NEC)

Definition

- Septic shock is a generalised, rapidly establishing tissue hypoperfusion due to dysregulated response to infection

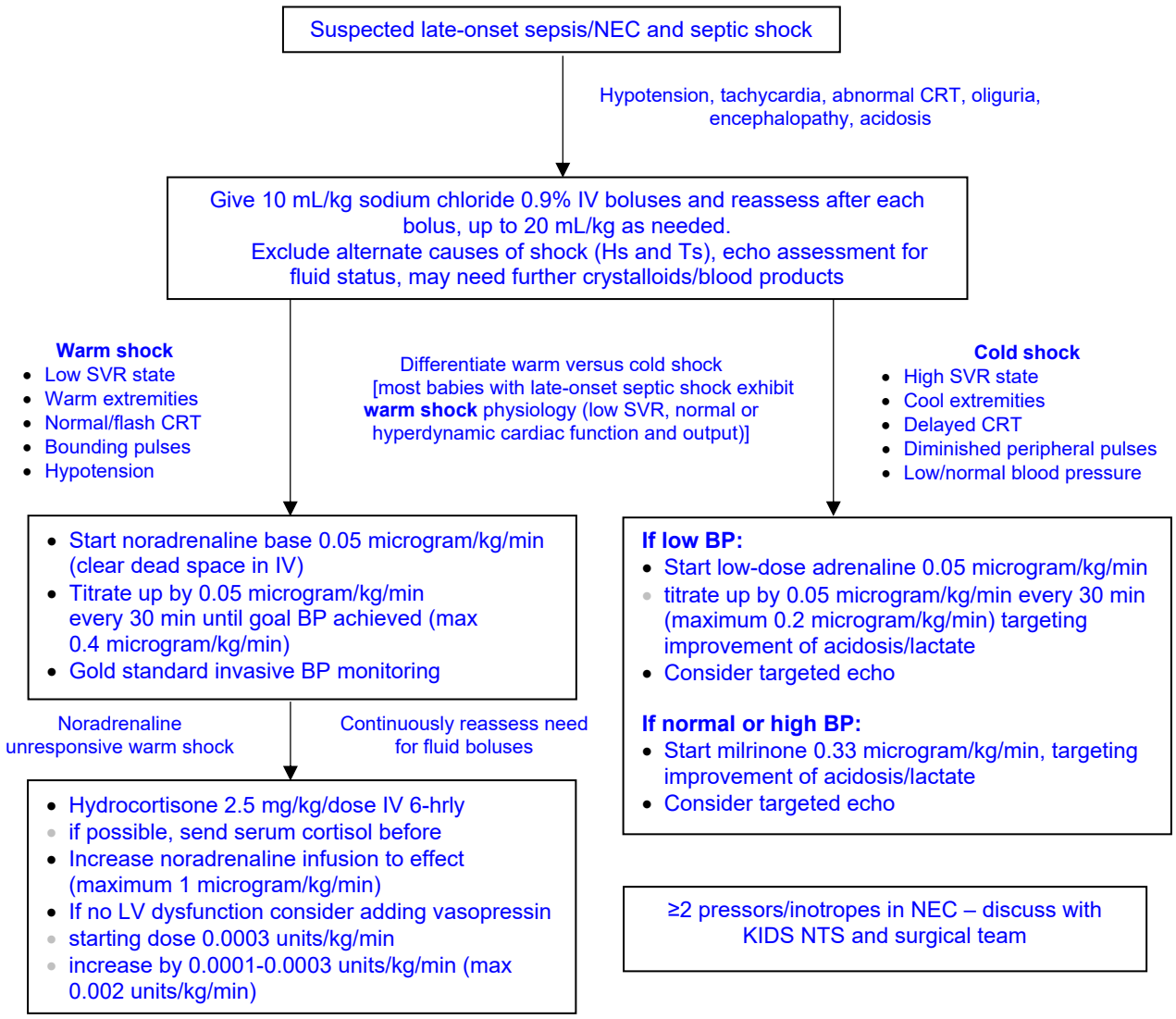
Pathophysiology and assessment

- Sepsis and NEC cause systemic inflammatory response syndrome (SIRS) which lead to endothelial dysfunction associated with vasodilation and capillary leak
- leading to low SVR and low effective circulating volume
- LV compensates by going into a hyperdynamic state to meet the energy demands by increasing heart rate and cardiac output (warm shock)
- Increased demands and the direct effect of endotoxins may cause myocardial dysfunction resulting in low cardiac output (cold shock)
- Warm shock is the most common presentation in neonates, but infants may progress to or initially present with cold shock

Approach to management

- Distinguish between cold and warm shock as management guided by underlying pathophysiology
- Warm shock characterised by low diastolic BP with normal to high systolic BP, bounding pulses, flushed appearance, tachycardia, and brisk capillary refill
- Cold shock presents with low systolic BP or severe/combined hypotension, cool peripheries, and prolonged capillary refill
- Echocardiography to assess filling and function recommended
- Vasodilatory (warm) shock use:
- volume expansion (crystalloids/blood products up to 20 mL/kg) as the first line agent
- start noradrenaline base 0.05–0.4 microgram/kg/min
- consider vasopressin in babies with severe vasoplegia refractory to noradrenaline
- Vasoconstrictive (cold) shock
- use volume expansion cautiously in view of myocardial dysfunction
- adrenaline 0.05–0.2 microgram/kg/min recommended as first line agent to augment myocardial contractility and SVR
- both adrenaline and noradrenaline may be needed in severe refractory shock
- If no response to first line inotropes, add hydrocortisone – dysfunction of HPA axis is common in severe sepsis
- Monitor urine output, electrolytes and renal function with vasopressin every 4–6 hr
- In NEC, if baby requiring escalating inotropic support, discuss with KIDS NTS and surgeons at BCH

Flowchart: Approach to management of septic shock in late-onset sepsis/NEC


Suspected late-onset sepsis/NEC and septic shock
Hypotension, tachycardia, abnormal CRT, oliguria, encephalopathy, acidosis
Give 10 mL/kg sodium chloride 0.9% IV boluses and reassess after each bolus, up to 20 mL/kg as needed.
Exclude alternate causes of shock (Hs and Ts), echo assessment for fluid status, may need further crystalloids/blood products
Warm shock
Low SVR state
Warm extremities
Normal/flash CRT
Bounding pulses
Hypotension
Differentiate warm versus cold shock
[most babies with late-onset septic shock exhibit warm shock physiology (low SVR, normal or hyperdynamic cardiac function and output)]
Cold shock
High SVR state
Cool extremities
Delayed CRT
Diminished peripheral pulses
Low/normal blood pressure
Start noradrenaline base 0.05 microgram/kg/min (clear dead space in IV)
Titrate up by 0.05 microgram/kg/min every 30 min until goal BP achieved (max 0.4 microgram/kg/min)
Gold standard invasive BP monitoring
Noradrenaline unresponsive warm shock
Continuously reassess need for fluid boluses
Hydrocortisone 2.5 mg/kg/dose IV 6-hrly
if possible, send serum cortisol before
Increase noradrenaline infusion to effect (maximum 1 microgram/kg/min)
If no LV dysfunction consider adding vasopressin
starting dose 0.0003 units/kg/min
increase by 0.0001-0.0003 units/kg/min (max 0.002 units/kg/min)
If low BP:
Start low-dose adrenaline 0.05 microgram/kg/min
titrate up by 0.05 microgram/kg/min every 30 min (maximum 0.2 microgram/kg/min) targeting improvement of acidosis/lactate
Consider targeted echo
If normal or high BP:
Start milrinone 0.33 microgram/kg/min, targeting improvement of acidosis/lactate
Consider targeted echo
≥2 pressors/inotropes in NEC – discuss with KIDS NTS and surgical team

HYPOTHYROIDISM ● 1/2

SCREENING

- Congenital hypothyroidism (CHT) is included in routine neonatal bloodspot screening at aged 5–8 days
- In preterm babies ≤31^{+6} weeks' gestation, repeat at aged 28 days or at discharge, whichever is sooner
- Screening relies on measurement of raised bloodspot TSH

Categorisation of initial screening result

- Based on TSH result in initial screening sample or second sample for baby <32 weeks' gestation
- <8 mU/L: negative result – CHT not suspected
- ≥20 mU/L: positive result – CHT suspected
- ≥8−<20 mU/L: borderline result
- Borderline result repeat sample 7−10 days after previous sample
- <8 mU/L: negative result − CHT not suspected
- ≥8 mU/L: positive result – CHT suspected

IMMEDIATE MANAGEMENT

Informing diagnosis

- If screening test result indicates CHT, a well-informed healthcare professional (community midwife, neonatal outreach nurse, health visitor or GP) must inform parents face-to-face
- do not communicate an abnormal result on Friday, Saturday or just before a weekend if consultant meeting cannot be arranged within next 24 hr
- provide parents with information leaflet **Congenital hypothyroidism is suspected** (available from: https://www.gov.uk/government/publications/congenital-hypothyroidism-cht-confirmed-description-in-brief/congenital-hypothyroidism-cht-further-information-for-families)

Consultant meeting

- Consultant to arrange to meet parents on same or next day to:
- explain abnormal result
- examine baby using screening laboratory proforma as an aide-mémoire
- look for other abnormalities (10% in CHT versus 3% in baby without CHT), congenital heart disease (pulmonary stenosis, ASD and VSD) is commonest anomaly
- commence treatment
- stress importance of daily and life-long treatment
- provide parent information leaflet (see **Informing diagnosis**)
- Document discussion, management plan and follow-up and send to GP and parents
- Complete and return data form to clinical biochemist at screening laboratory

Obtain further diagnostic tests

- **Baby**
- 1 mL venous blood in heparinised container for FT4 and TSH
- send repeat dried bloodspot card to screening laboratory
- 1 mL venous blood for serum thyroglobulin
- ultrasound or radionuclide scan of thyroid, latter preferably within 5 days of starting levothyroxine; ultrasound can be performed at any age
- **Mother**
- take 3 mL venous blood into a heparinised container for FT4, TSH and thyroid antibodies

TREATMENT

- Start treatment with levothyroxine after obtaining confirmatory blood tests. Do not wait for results unless transient hypothyroidism suspected. Treatment must start before aged 14 days. For those detected on repeat sampling, treatment should ideally commence by 21 days
- after discussion with paediatric endocrinologist, consultant may withhold treatment if transient hypothyroidism suspected
- Starting dose levothyroxine 10–15 microgram/kg/day with maximum daily dose of 50 microgram. Aim to maintain serum FT4 in upper half of normal range by 2 weeks treatment and for normalisation of TSH by 4 weeks
- Adjustment required depending on thyroid function test results
- Tablets are 25 microgram strength
- it is not necessary to divide tablets for intermediate dose; administer intermediate dose, e.g. 37.5 microgram, as 25 and 50 microgram on alternate days

- Crush required levothyroxine dose using tablet crusher (if tablet crusher not available, between 2 metal spoons) and mix with a little milk or water, using teaspoon or syringe
- do not add to bottle of formula
- suspensions not advised due to variable bioavailability
- repeat dose if baby vomits or regurgitates immediately
- Record date treatment commenced
- Provide parents with 28 day prescription for levothyroxine
- Arrange continued prescription with GP, emphasising need to avoid suspensions

FOLLOW–UP

- Arrange follow-up after commencement of hormone replacement therapy as follows:
- 2 weeks, 4 weeks, 8 weeks, 3 months, 6 months, 9 months, 1 yr, 18 months, 2 yr, 30 months, 3 yr, yearly thereafter
- At each clinic visit:
- physical examination, including height, weight and head circumference
- developmental progress
- blood sample for thyroid function test (FT4, FT3 and TSH, just before usual daily medication dose)
- request as **FT4 priority, then TSH**

Interpretation of thyroid function test results

Analyte	Age	Concentration
FT4 (pmol/L)	0–5 days	17–52
	5–14 days	12–30
	14 days–2 yr	12–25
TSH (mU/L)	0–14 days	1–10
	15 days–2 yr	3.6–8.5

Check reference ranges with your laboratory's assay

- Aim for FT4 towards upper limit of normal range
- at higher concentrations of FT4, normal concentrations of T3 (produced by peripheral conversion) are achieved
- if FT4 concentration satisfactory but with significantly raised TSH, consider non-compliance
- TSH concentration does not always normalise under 6 months and may be slightly raised up to aged 3 yr in absence of non-compliance, probably due to reset feedback mechanism
- Overtreatment may induce tachycardia, nervousness and disturbed sleep patterns, and can produce premature fusion of cranial sutures and epiphyses. If symptoms of overtreatment or very suppressed TSH, reduce dose of levothyroxine

AFTERCARE

- Reassure parents that baby will grow into healthy adult with normal intelligence
- Stress importance of regular treatment. **As half-life is long, it is not necessary to give an extra tablet next day if a day's treatment missed**

HYPOTONIA (FLOPPY BABY) ● 1/5

RECOGNITION AND ASSESSMENT

Hypotonia can be a relatively common finding in the newborn period and may be transient in the majority of cases, but if it is severe and/or persistent then further investigation indicated

Definition

- Subjective decrease in resistance to passive movement
- Separate from weakness, which refers to lack of muscle strength
- Important to differentiate between central (upper motor neurone), and peripheral (lower motor neurone) hypotonia – may be a mixed picture. See **Table 1**
- central hypotonia is most common (70–80%)

Signs

- Reduced activity/movement
- Reduced level of consciousness/alertness
- High pitched, weak or fatigable cry
- Increased or reduced respiratory effort
- Feeding difficulties/choking/pooling of secretions
- Seizures/abnormal movements
- **Note**: Look for syndrome-associated dysmorphic features

DIFFERENTIAL DIAGNOSIS

- Causes of hypotonia in the newborn baby are numerous, not all are listed here
- Benign congenital hypotonia is a diagnosis of exclusion

Central

- Hypoxic ischaemic encephalopathy (HIE)
- Intracranial haemorrhage
- Structural brain malformation
- Chromosomal abnormalities e.g. trisomy 21, Prader-Willi syndrome
- Congenital infection e.g. TORCH
- Acquired infection e.g. Group B *Streptococcus*
- Endocrine e.g. congenital hypothyroidism
- Metabolic disorders e.g. acid maltase deficiency (Pompe's disease), carnitine deficiency, mucopolysaccharidosis, peroxisome biogenesis disorders e.g. Zellweger syndrome
- Drug effects e.g. benzodiazepines

Peripheral

- Spinal cord e.g. birth trauma (especially breech delivery), syringomyelia
- Anterior horn cell e.g. spinal muscular atrophy (SMA)
- Neuromuscular junction e.g. myasthenia gravis, transitory myasthenia
- Peripheral nerves e.g. hereditary motor and sensory neuropathies e.g. Charcot Marie-Tooth disease
- Muscle disorders e.g. muscular dystrophy, congenital myopathy

HISTORY

Family

- Affected parents/siblings
- Consanguinity
- Previous miscarriage/stillbirth
- Metabolic/genetic disease
- Premature death

Maternal

- Diabetes
- Infection
- Medications e.g. antidepressants
- Myotonic dystrophy
- Myasthenia gravis

Antenatal
- TORCH infections
- Drug/alcohol exposure
- Fetal movements
- Liquor volume

Birth
- Gestational age
- Delivery complications
- Malpresentation
- Instrumental delivery
- APGAR score/resuscitation at birth
- Cord gases

Neonatal
- Respiratory distress
- Feeding issues
- Level of alertness
- Level of spontaneous movement
- Seizures
- Hypoglycaemia
- Weak cry
- Medication e.g. aminoglycoside toxicity

PHYSICAL EXAMINATION

Mother
- Examine for signs of myotonic dystrophy

Baby
- Full neurological assessment
- Level of alertness
- Abnormal posture
- Degree of hypotonia
  - pull to sit – significant head-lag
  - scarf sign
  - shoulder suspension − 'slipping through hands'
  - ventral suspension
  - frog-leg posture
- Asymmetry
- Strength
- Deep tendon reflexes
- Primitive reflexes
- Gag and suck
- Fasciculations (including tongue)
- Abnormal eye movements
- Ptosis
- Cataracts
- Dysmorphic features/abnormal facies
- Respiratory effort
- Hepatosplenomegaly
- Undescended testicles
- Contractures
- Arthrogryposis
- Serial neurological examination for progression of hypotonia or weakness (see **Table 1**)

Table 1: Summary of typical findings according to cause

Central hypotonia	Peripheral hypotonia			
	Anterior horn cell	Nerve	Neuromuscular junction	Muscle
Normal strength	Generalised weakness	Weakness (distal>proximal)	Weakness, including face/eyes/bulbar	Weakness (proximal>distal), including face, extraocular muscles
Normal/ increased deep tendon reflexes (DTRs) Clonus	Decreased/ absent DTRs	Decreased/ absent DTRs	Normal DTRs	Decreased DTRs
+/- Seizures	Fasciculations	+/- Fasciculations	No fasciculations	
+/- Dysmorphic features, reduced alertness	Often described as alert		+/- Arthrogryposis	+/- Contractures

© Auckland District Health Board

Babies with profound central hypotonia may have absent deep tendon reflexes; this sign may not reliably rule out a central cause of hypotonia in first few days of life

- Weakness uncommon in central hypotonia – except in acute stages
- points to lower motor neurone disorder

- Clinical findings which may direct to a specific diagnosis:
- hepatosplenomegaly – storage disorders, congenital infections
- hypopigmentation, undescended testes – Prader-Willi syndrome
- hepatomegaly, retinitis pigmentosa – neonatal adrenoleukodystrophy
- renal cysts, high forehead, wide fontanelle – Zellweger syndrome
- congenital cataracts, glaucoma, proteinuria – oculocerebrorenal (Lowe) syndrome
- abnormal odour – metabolic disorders

INVESTIGATIONS

- Guided by detailed history and clinical examination
- If hypotonic with a degree of strength, central cause is most likely
- If hypotonic and weak, peripheral cause is possible. Discuss with neurologist
- Involve relevant specialist team early

Table 2: Investigation of the hypotonic baby

	Investigation
Infection screen	• FBC • CRP • Blood culture • CSF for microscopy, culture and sensitivity • CSF for protein and glucose • Congenital infection screen (TORCH) ◦ serum (toxoplasmosis/herpes simplex/rubella) ◦ urine (CMV)
Metabolic screen	• Blood glucose • Blood gas • Serum lactate • Serum ammonia • Serum amino acids • Carnitine/acylcarnitine • Very long chain fatty acids • Plasma glycine • Urinary organic and amino acids • Urinary glycosaminoglycans (GAGs) • CSF lactate and glycine
Endocrine screen	• Thyroid function (TSH and T4) • U&Es • Calcium • Magnesium (hyper-/hypo- e.g hypermagnesaemia after treatment for maternal eclampsia)
Genetic screen	• Karyotype and microarray • 'Hypotonia panel' – may include: ◦ DNA for Prader-Willi, Zellweger syndrome ◦ SMA gene (SMA-RD – if respiratory weakness) ◦ DMPK gene (Myotonic Dystrophy gene) ◦ whole exome sequencing (discuss with geneticist) • Other specific genetic test guided by family history/phenotype
Other	• Cranial ultrasound scan • MRI brain +/- spinal cord • aEEG (if features of encephalopathy or metabolic condition suspected) • EEG (especially if seizures, but consider even if no clinical seizure) • Creatinine kinase (muscular dystrophy) ◦ may be elevated in first few days after birth ◦ if abnormal, repeat after aged 72 hr ◦ if persistently elevated, refer to neurologist and consider muscle biopsy* • Nerve conduction studies • If features of maternal myasthenia gravis: ◦ acetylcholine receptor antibodies ◦ tensilon test ◦ EMG • If cardiomyopathy suspected: ◦ ECG ◦ chest X-ray ◦ echocardiography • Muscle biopsy*

Muscle biopsy may be delayed until aged 6 months, as neonatal results are difficult to interpret

MANAGEMENT

- Specific management determined by individual condition and presentation
- Airway and breathing
  - may need resuscitation at birth

- airway positioning/Guedel airway
- intubation and ongoing respiratory support
- suction of respiratory secretions
- Feeding
- specialised bottles/teats
- nasogastric tube feeds
- early speech and language team involvement (where available)
- Skin and developmental care
- regular position changes to avoid pressure sores, reduce risk of contractures and optimise neurodevelopment (see **Developmental care** guideline)
- Physiotherapy
- refer to neonatal/paediatric physiotherapy (while inpatient)
- physiotherapist will:
  - advise on **specific** handling and positioning to optimise neurodevelopmental outcomes
  - assess for symmetry and risk of joint contractures/positional deformity and advise on management
- on discharge refer to community paediatric physiotherapy services
- Early involvement of neurologist, and other specialist teams as indicated

IMMUNISATIONS● 1/3

ROUTINE IMMUNISATIONS FOR ALL BABIES

- Plan to achieve immunity to diphtheria, tetanus, pertussis, (DTaP), polio, *Haemophilus* (Hib), meningococcus B, pneumococcus, rotavirus and hepatitis B within 4 months of birth (see also **BCG immunisation** and **Hepatitis B and C** guidelines)
- See Department of Health Immunisation against Infectious Diseases 'Green Book' for national policy and for current schedule see https://www.gov.uk/government/collections/immunisation

Do not delay immunisation in preterm babies because of prematurity or low body weight

CONTRAINDICATIONS

- Cardiorespiratory events (apnoeas, bradycardia and desaturations) are not contraindications to immunisation, but continue to monitor for a further 72 hr following immunisation
- See **Precautions with rotavirus vaccine**

PROCEDURE

Consent

- Inform parents of process, benefits and risks
- For further information refer parents to www.nhs.uk/conditions/vaccinations
- Offer parents opportunity to ask questions
- Informed consent (can be written or oral) must be obtained and recorded in notes at time of each immunisation
- Inform local Child Health Information System (CHIS)

Prescription

Use immunisation listed in 'Green Book' – see **Routine immunisations for all babies**

- Keep strictly to schedule to avoid delay
- Order vaccines in advance unless held as stock on NNU
- Prescribe on treatment sheet

Administration

- DTaP/IPV/Hib/HepB (Infanrix Hexa®) is a 6-in-1 preparation
- Administer by IM injection into thigh; give ≥2.5 cm away from other vaccination sites
- Dose for all primary immunisations (DTaP/IPV/Hib/HepB), meningococcal B, pneumococcal) is 0.5 mL
- Give meningococcal B (Bexsero®) and pneumococcal (Prevenar 13®) vaccine into separate injection sites in other thigh
- Rotavirus vaccine must **not** be injected and preferably **not** given via an NGT
- assess ability to tolerate oral administration

DOCUMENTATION

- After immunisation, document the following in case notes as well as in Personal Child Health Record (Red Book):
- consent gained from parents
- vaccine given and reasons for any omissions
- site of injection(s) in case of reactions
- batch number of product(s)
- expiry date of product(s)
- legible signature and GMC number of doctor or NMC number of advanced neonatal nurse practitioner administering immunisations
- adverse reactions
- Sign treatment sheet
- Complete immunisation form in **BadgerNet** system. Document all information on discharge summary and medical case notes, including recommendations for future immunisations and need for any special vaccinations etc., e.g. influenza, palivizumab, etc.
- Notify CHIS

MONITORING

- Babies born <28 weeks may have an impaired immune response. Check functional antibodies 1 month after booster at aged 1 yr, if needed
- Babies <28 weeks' gestation at birth, who are in hospital – respiratory monitoring for 48–72 hr when given first routine immunisations
- If baby has apnoea, bradycardias or desaturations after first routine immunisations, second immunisation should ideally be given in hospital with respiratory monitoring for 48–72 hr

ADVERSE REACTIONS

- Local:
- extensive area of redness or swelling
- General:
- fever >39.5°C within 48 hr
- anaphylaxis
- bronchospasm
- laryngeal oedema
- generalised collapse
- episodes of severe apnoea
- diarrhoea
- irritability
- vomiting
- flatulence
- loss of appetite
- regurgitation
- Report any other serious reactions via Yellow Card (see https://yellowcard.mhra.gov.uk/)

Specific notes for rotavirus vaccination

- Do not give Rotarix® to babies aged <6 weeks
- minimum age for first dose of Rotarix® is 6^{+0} weeks
- maximum age for first dose is 14^{+6} weeks
- Do not give first dose of Rotarix® to babies aged ≥15^{+0} weeks. Babies who have received their first dose of vaccine aged <15^{+0} weeks should receive their second dose of Rotarix® after a minimum interval of 4 weeks and by aged 23^{+6} weeks
- Do not give Rotarix® vaccine to babies aged ≥24^{+0} weeks

Precautions with rotavirus vaccination

- Postpone administration of rotavirus vaccine in babies suffering from:
- acute severe febrile illness
- acute diarrhoea or vomiting
- first dose must be given aged <15 weeks
- Do not administer Rotarix® to babies with:
- confirmed anaphylactic reaction to a previous dose of rotavirus vaccine
- confirmed anaphylactic reaction to any components of the vaccine
- history of intussusception
- aged ≥24^{+0} weeks
- severe combined immunodeficiency disorder (SCID)
- maternal immunosuppressive biological therapy in pregnancy
- malformation of the gastrointestinal tract that could predispose them to intussusception
- rare hereditary problems of fructose intolerance, glucose-galactose malabsorption or sucrase-isomaltase insufficiency

ADDITIONAL IMMUNISATIONS

Influenza (in autumn and winter only)

Indications

- Chronic lung disease (on, or recently had, oxygen)
- Congenital heart disease, renal, liver or neurological disease
- Immunodeficiency

Recommendations

- Recommend vaccination to close family members of these babies
- Give babies aged >6 months–2 yr, 2 doses 4–6 weeks apart, IM injection
- **Note**: intranasal flu vaccine is now routinely recommended for children aged ≥2 yr

Palivizumab
See **Palivizumab** guideline

BCG
See **BCG immunisation** guideline

Hepatitis B
See **Hepatitis B and C** guideline for babies born to mothers with these infections

HIV

- See **Human immunodeficiency (HIV)** guideline
- Babies who are HIV infected, or HIV exposed (born to HIV positive mother) and status not yet known:
- routine immunisations including rotavirus vaccine not contraindicated
- if BCG indicated, see **BCG immunisation** guideline. If baby deemed to be low risk or very low risk of HIV transmission, do not delay BCG immunisation

Routine immunisation schedule aged ≤16 weeks
See https://www.gov.uk/government/publications/the-complete-routine-immunisation-schedule

INFECTION (LATE ONSET) ● 1/5

Late-onset neonatal infection (infection arising >72 hr after birth) has a higher incidence than early-onset neonatal infection (infection arising within 72 hr of birth) and the spectrum of causative micro-organisms is broader than in early-onset infection

DEFINITION

- Infection presenting >72 hr after birth
- When acquired in hospital – most commonly Gram-positive organisms. Coagulase-negative staphylococci (CoNS) account for approximately 50% of all late onset infections
- Gram-negative bacteria accounts for 20–40% and these are increasingly resistant to gentamicin (*Klebsiella>Serratia>Enterobacter>Pseudomonas>E.coli* and *Acinetobacter*)

Risk factors

- Prematurity
- Low-birth-weight
- Mechanical ventilation
- History of surgery
- Presence of central catheter
- Parenteral nutrition
- delayed introduction of enteral feeds is associated with higher infection rates
- Increased risk of sepsis after gut surgery especially if enteral feeds slow to establish e.g. post-gastroschisis or necrotising enterocolitis (NEC) with stoma
- Think about infection in the other babies when one baby from a multiple birth has infection

PREVENTION

- Bare below elbow
- no jewellery except wedding band
- **Strict hand washing and alcohol hand rubs**
- Follow WHO **5 moments of hand hygiene** recommendations
- Meticulous regimen for changing IV fluid administration sets and 3-way taps
- Initiate enteral feeds with maternal breast milk within 6 hr of birth

PRESENTATION

- Can be vague and non-specific

Signs

Behaviour

- Parent or care-giver concern for change in behaviour
- Appears ill to healthcare professional
- Does not wake, or if roused does not stay awake
- Weak high-pitched or continuous cry

Respiratory

- Raised respiratory rate: ≥60 breaths/min
- Grunting and other signs of increased work of breathing
- Apnoea
- Oxygen saturation of <90% in air or increased oxygen requirement over baseline

Circulation and hydration

- Persistent tachycardia: heart rate ≥160 beats/min
- Persistent bradycardia: heart rate <100 beats/min

Skin

- Mottled or ashen appearance
- Cyanosis of skin, lips or tongue
- Non-blanching rash

GI

- Alteration in feeding pattern
- Distension and tenderness

- Reduced or absent bowel sounds
- Blood in stool

Other
- Temperature <36°C **or** ≥38°C, unexplained by environmental factors
- Reluctance to move joint or limb (suggestive of osteomyelitis or septic arthritis)
- Septic spots in eyes, umbilicus, nails or skin
- Bulging fontanelle suggesting raised intracranial pressure (rarely detectable in babies with neonatal meningitis)
- Seizures
- Petechiae

INVESTIGATIONS (perform before starting antibiotics)

Swabs or ETT secretions for culture
- Swab any suspicious lesion (e.g. skin, umbilicus or nails)
- Refer to recent swabs or ETT secretion cultures to guide antibiotic therapy

Blood cultures
- From a peripheral vein, using a **closed system**, non-touch, aseptic technique
- If blood collected from cannula hub risk of culturing CoNS skin contaminants

Full blood count
- A neutrophil count <2 or >15 × 10^9/L (supportive but not diagnostic, and marginally more sensitive than a total white cell count)
- Platelet count of <100 × 10^9/L
- Toxic granulation in neutrophils [or if measured, an immature:total (I:T) neutrophil ratio >0.2]

Clotting profile
- If evidence of bleeding diathesis or in severe infection/septicaemia

CRP
- Acute phase protein synthesised in the liver in response to inflammatory cytokines
- Generally a delay of 18−24 hr between onset of symptoms and rise in serum CRP
- Take sample at presentation and further sample 18–24 hr after first CRP sample; use this together with later readings to assess the likelihood of infection and response to treatment

Urine microscopy, culture and sensitivity
- Do not routinely perform urine microscopy or culture as part of the investigations for late-onset neonatal infection for babies in neonatal units
- For babies outside of neonatal units follow the NICE guideline on urinary tract infection in under 16s – see https://www.nice.org.uk/guidance/ng224

Lumbar puncture (LP)
- If safe to do so, perform LP to obtain cerebrospinal fluid sample when:
  - strong clinical suspicion of neonatal infection or
  - clinical symptoms or signs suggesting meningitis
- If baby unstable, deranged clotting or thrombocytopenia, discuss advisability with consultant
- Send CSF for urgent Gram-stain and culture (MC&S), protein and glucose
  - PCR for bacteria and viruses where indicated
- In critically ill baby, consider PCR for HSV, especially term babies

Others
- Chest X-ray
- If abdominal distension noted, abdominal X-ray
- Consider removing central lines for all infections (unless access major issue). Line removal should be a considered decision
- If line 'precious' and baby responding to treatment, consider infusing vancomycin down long line in accordance with local formulary

Documentation

- Always document symptoms and signs of infection **at the time of taking all blood and CSF cultures** (and abdominal radiographs) on **BadgerNet** ad-hoc reporting field

EMPIRICAL TREATMENT

Do not use oral antibiotics to treat infection in babies
Consult local microbiology department for current recommendations. These may differ between units according to local resident flora

Late onset sepsis

Antibiotics

- **If decision made to give antibiotics, aim to start within <30 min and always within ≤1 hr of decision**
- **First line**: give combination of IV antibiotics (e.g. flucloxacillin plus gentamicin) based on local or national susceptibility and resistance data
- Give antibiotics effective against both Gram-negative and Gram-positive bacteria
- If necrotising enterocolitis suspected, include antibiotic that is active against anaerobic bacteria (e.g. metronidazole) (see **Necrotising enterocolitis** guideline)
- **Second line suggested:** vancomycin + gentamicin − review local antibiotic susceptibility and resistance data (or national data if local data inadequate)
- **Third line** or if cultures dictate: meropenem +/- vancomycin, tazobactam + piperacillin alternative for Gram-negative infection
- **Do not use vancomycin** routinely:
  - for babies with indwelling catheters and on parenteral nutrition, or to treat endotracheal secretion colonisation with CoNS

Antifungals

- Give prophylactic oral nystatin to babies treated with antibiotics for suspected late-onset neonatal bacterial infection if:
  - birth weight ≤1500 g **or**
  - born <30 weeks' gestation
- Consider antifungals in post gut surgery babies at any gestation
- If oral administration of nystatin is not possible, give fluconazole IV

Review treatment at 36 hr

- Stop antibiotics if:
  - initial clinical suspicion of infection was not strong **and**
  - negative blood culture **and**
  - baby is well with no clinical indicators of possible infection **and**
  - levels and trends of CRP are reassuring i.e. CRP <15 mg/L on both tests

Treatment duration for late-onset neonatal infection without meningitis

- When culture results available, always change to narrowest spectrum antibiotic
- If positive blood culture, give for 7 days
- consider continuing antibiotic treatment >7 days if:
  - baby not yet fully recovered **or**
  - longer treatment required due to pathogen identified on blood culture (e.g. Gram-negative bacteria or *Staphylococcus aureus;* seek expert microbiological advice if necessary) **or**
  - longer treatment required due to site of infection (e.g. intra-abdominal co-pathology, necrotising enterocolitis, osteomyelitis or infection of a central venous catheter)
- If baby makes prompt recovery, and either no pathogen identified/pathogen identified is a common commensal (e.g. coagulase negative staphylococcus), treat <7 days
- If continuing antibiotics >48 hr for suspected late-onset neonatal infection despite negative blood culture, review the baby at least once every 24 hr
- at each review, decide whether to stop antibiotics, taking account of:
  - level of initial clinical suspicion of infection **and**
  - baby's clinical progress and current condition **and**
  - levels and trends of C-reactive protein

SPECIFIC INFECTIONS

Discharging eyes

- See **Conjunctivitis** guideline

Umbilicus sepsis (omphalitis)

- Systemic antibiotics required **only** if local induration or surrounding reddening of the skin

Meningitis

For all babies with a positive blood culture, other than CoNS, discuss the need for an LP with an experienced clinician. Organisms such as group B streptococci and E. coli penetrate the CSF readily

Empirical treatment whilst CSF results pending

- If meningitis suspected but causative pathogen unknown, treat with amoxicillin IV and cefotaxime IV
- If meningitis caused by a Gram-negative infection, stop amoxicillin and treat with cefotaxime alone
- If meningitis caused by Gram-positive organism, continue with amoxicillin and cefotaxime until culture result confirmed
- Seek microbiological advice where possible
- If CSF culture positive for group B streptococci consider changing antibiotic treatment to benzylpenicillin for at least 14 days and gentamicin IV for 5 days
- If blood culture or CSF positive for *Listeria,* consider stopping cefotaxime and treating with amoxicillin and gentamicin
- If CSF culture identifies a Gram-positive bacterium other than group B streptococcus or *Listeria* seek microbiological advice

Table of normal CSF values

Gestation	White cell count (count/mm^3)	Protein (g/L)	Glucose (mmol/L)
Preterm <28 days	9 (0–30)	1.0 (0.5–2.5)	3.0 (1.5–5.5)
Term <28 days	6 (0–21)	0.6 (0.3–2.0)	3.0 (1.5–5.5)

- Values are mean (range)
- **Note**: protein levels are higher in first week of life and depend on RBC count. WBC of >21/mm^3 with a protein of >1.0 g/L with <1000 RBC is suspicious of meningitis
- If traumatic LP and strong suspicion of meningitis, repeat LP after 24–48 hr
- Manage baby as if he/she has meningitis. None of the 'correcting' formulae are reliable

Urinary tract infection (UTI)

- Do not routinely perform urine microscopy or culture in babies suspected of late onset sepsis on neonatal units
- if a urine microscopy and culture are requested this specimen should be a clean catch specimen. When it is not possible to collect urine by non-invasive methods catheter samples or suprapubic aspiration should be used

Necrotising enterocolitis

- See **Necrotising enterocolitis (NEC)** guideline

Fungal infection

- Mostly late onset
- Incidence in UK up to 1.2% in very-low-birth-weight babies and 2.6% in extremely-low-birth-weight babies (versus up to 28% in the USA), hence no routine prophylaxis in the UK for those babies not receiving antibiotics

Risk factors

- <1500 g
- Parenteral nutrition
- Indwelling catheter
- No enteral feeds
- Ventilation
- H2 antagonists

- Exposure to broad spectrum antibiotics, especially cephalosporins
- Abdominal surgery
- Peritoneal dialysis

Symptoms and signs

- Non-specific
- as for early onset infection

Additional investigations

- If fungal infection suspected or diagnosed, end-organ evaluation to include:
- abdominal ultrasound
- cerebral ultrasound
- lumbar puncture
- fundoscopy
- echocardiogram
- blood cultures 24–48 hrly to confirm clearance
- suprapubic or catheter specimen of urine

Treatment

First choice

- Standard amphotericin (Fungizone®) starting at 1 mg/kg once daily. Can increase dose as tolerated to 1.5 mg/kg once daily. In renal failure can use liposomal amphotericin (AmBisome®) 1 mg/kg once daily increasing to a maximum of 5 mg/kg once daily (see **Neonatal Formulary** for doses and intervals)
- Alternatives fluconazole and micafungin – see local formulary

ADJUNCTIVE THERAPY

- No substantive trials to date show benefit of immunoglobulin IV, recombinant cytokines etc.

INFECTION IN FIRST 72 HOURS OF LIFE ● 1/3

Based on **NICE NG195 Neonatal infection: antibiotics for prevention and treatment** April 2021 and **NICE QS75 Neonatal infection** December 2014 (updated January 2024)

RISK FACTORS FOR INFECTION

Red flag risk factor

- Suspected or confirmed infection in another baby in the case of a multiple pregnancy

Other risk factors

- Invasive Group B streptococcal infection in a previous baby
- Maternal Group B streptococcal colonisation, bacteriuria or infection in the current pregnancy
- Preterm birth (<37 weeks) following spontaneous labour
- Confirmed rupture of membranes for >18 hr before a preterm birth
- Confirmed pre-labour rupture of membranes at term for >24 h before onset of labour
- Intrapartum fever >38°C if there is confirmed or suspected bacterial infection
- Clinical diagnosis of chorioamnionitis

CLINICAL INDICATORS SUGGESTIVE OF INFECTION

Red flag clinical indicators

- Apnoea
- Need for cardiopulmonary resuscitation
- Seizures
- Need for mechanical ventilation
- Signs of shock

Other clinical indicators

- Altered behaviour or responsiveness
- Altered muscle tone (e.g. floppiness)
- Feeding difficulties (e.g. feed refusal)
- Feed intolerance including abdominal distension, vomiting, excessive gastric aspirates
- Abnormal heart rate (bradycardia or tachycardia)
- Signs of respiratory distress (including grunting, recession, tachypnoea)
- Hypoxia (e.g. central cyanosis or reduced oxygen level)
- Jaundice in first 24 hr of life
- Signs of neonatal encephalopathy
- PPHN
- Temperature <36°C or >38°C, not explained by environmental factors
- Unexplained excessive bleeding, thrombocytopenia or abnormal coagulation
- Hypo/hyperglycaemia
- Metabolic acidosis (BE ≥10)

ACTIONS

- Any red flags or no red flags but ≥2 risk factors **or** clinical indicators
  - perform investigations, including blood cultures, and start antibiotics
- No red flag or clinical indicators but 1 risk factor, **or** no red flag or risk factors but 1 clinical indicator
  - use clinical judgement and consider withholding antibiotics
  - monitor baby for clinical indicators of possible infection, including vital signs
  - monitor for at least 12 hr from birth (at 1 hr, 2 hr and then 2-hrly for 10 hr)
- If further clinical concerns, perform investigations including blood cultures and start antibiotics
- Whenever decision made to give antibiotics, start as soon as possible and always within 1 hr of decision

KAISER PERMANENTE SEPSIS RISK CALCULATOR (KP-SRC)

- Online tool used to determine whether a baby is at risk of early onset neonatal infection and whether antibiotic treatment is indicated. NICE has endorsed this as an alternative to the framework above and below for babies born at ≥34 weeks
- In this guideline the KP-SRC is applied to well babies who meet the NICE criteria for treatment with antibiotics for possible early onset neonatal infection to determine whether they should receive antibiotics

- If baby meets the criteria for antibiotic treatment refer to the **Kaiser Permanente sepsis risk calculator** guideline and apply KP-SRC online tool
- If KP-SRC recommends withholding antibiotics continue to follow the **Kaiser Permanente sepsis risk calculator** guideline
- Continue with this guideline, following the advice below if:
- KP-SRC recommends antibiotic treatment **or**
- baby does not meet the KP-SRC inclusion criteria **or**
- online tool is not available **or**
- local trust has chosen not to adopt KP-SRC

INVESTIGATIONS BEFORE STARTING ANTIBIOTICS

- Blood culture (in all)
- Measure CRP at presentation and 18–24 hr after
- If strong clinical suspicion of any infection or signs of meningitis, perform lumbar puncture (LP), if thought safe to do
- if performing LP will delay antibiotics, give antibiotics first
- Do not carry out routine urine MC&S
- Take skin swabs only if clinical signs of localised infection
- If purulent eye discharge (may indicate serious infection e.g. *Chlamydia* or gonococcus):
- collect eye swabs for urgent MC&S and swabs in viral transport media for viral PCR, especially if looking for *Chlamydia* or gonococcus (see **Conjunctivitis** guideline)
- start systemic antibiotics while awaiting results
- If signs of umbilical infection, including purulent discharge or periumbilical cellulitis, perform blood culture, take swab for MC&S and start flucloxacillin and gentamicin IV
- if microbiology results indicate infection not due to Gram-negative infection stop gentamicin

Choice of IV antibiotics

- Use benzylpenicillin and gentamicin as first choice for empirical treatment
- If microbiological evidence of Gram-negative bacterial sepsis, add a third antibiotic that is active against Gram-negative bacteria e.g. cefotaxime. If Gram-negative infection subsequently confirmed, stop benzylpenicillin

Benzylpenicillin

- 25 mg/kg 12-hrly
- If baby appears very ill, give 25 mg/kg 8-hrly

Gentamicin

- Follow local guideline or:
- 5 mg/kg
- if a second dose to be given (see below), give 36 hr after first dose
- interval may be shortened based on clinical judgement e.g. for Gram-negative infection or if baby appears very ill
- Monitoring of gentamicin – see below

INVESTIGATIONS DURING ANTIBIOTIC TREATMENT

- CRP: measure before starting antibiotics and 18–24 hr after presentation
- Consider LP if:
- positive blood culture (other than CoNS) **or**
- baby does not respond satisfactorily to antibiotics **or**
- there is a strong clinical suspicion of infection **or**
- there are clinical symptoms or signs suggestive on meningitis
- Asymptomatic babies on postnatal ward/transitional care unit with CRP ≤60 do not require routine LP, but should be reviewed by tier 2 staff

Review treatment at 36 hr

- Stop antibiotics if:
- initial clinical suspicion of infection was not strong **and**
- negative blood culture **and**

- baby is well with no clinical indicators of possible infection **and**
- levels and trends of CRP are reassuring i.e. CRP <15 mg/L on both tests

Usual duration of treatment

- If blood culture negative and baby is well with no strong clinical suspicion of infection and neither CRP >60, antibiotics can be stopped after 5 days
- If blood culture positive or strong clinical suspicion of infection or either CRP >60, treat for 7 days
- Continue treatment beyond 7 days if:
- baby is not fully recovered **or**
- this is advisable based on blood culture result and expert microbiological advice if necessary
- If any doubt about duration of treatment, discuss with consultant

Meningitis

- If meningitis suspected but Gram stain is uninformative, use amoxicillin and cefotaxime
- Review treatment decisions taking CSF results into account
- If CSF Gram stain suggests GBS, give benzylpenicillin 50 mg/kg 12-hrly and gentamicin 5 mg/kg every 36 hr
- If CSF culture confirms GBS, continue benzylpenicillin for ≥14 days and gentamicin for 5 days
- If CSF culture or Gram stain confirms Gram-negative infection, stop amoxicillin and treat with cefotaxime alone
- If blood culture or CSF culture positive for *Listeria*, consider stopping cefotaxime and treating with amoxicillin and gentamicin
- If CSF Gram stain or culture suggests any organism other than GBS, use an antibiotic regimen based on local expert microbiological advice

Therapeutic monitoring of gentamicin

- Follow local guidelines or:
- **Trough concentrations**:
- if second dose to be given, measure before administering
- review level before giving third dose
- monitor before every third dose, or more frequently if necessary (e.g. concern about previous level or renal impairment)
- adjust dose interval aiming to achieve level of <2 mg/L
- if course lasts >3 doses, level of <1 mg/L is advisable
- if a trough level is not available, do not withhold next dose of gentamicin unless there is evidence of renal dysfunction (raised serum urea, creatinine or anuria)
- **Peak concentrations**:
- measure in selected babies e.g.:
  - with oedema
  - with macrosomia (birth weight >4.5 kg)
  - unsatisfactory response to treatment
  - proven Gram-negative infection
- Measure 1 hr after starting gentamicin infusion
- If peak <8 mg/L, increase dose

DISCHARGE FOLLOWING GROUP B STREPTOCOCCAL INFECTION

- Advise mother that if she becomes pregnant again:
- increased risk of early onset neonatal infection
- to inform her maternity team that a previous baby had GBS infection
- intrapartum antibiotics will be recommended
- Inform mother's GP in writing risk of:
- recurrence of GBS infection in this baby
- GBS infection in subsequent pregnancies
- If mother had GBS colonisation in this pregnancy but no infection in baby, this will not affect management of any further births

INFECTION PREVENTION • 1/3

Special measurements to be in place on NNU due to high risk and high consequences of infection. Standard precautions to be taken to avoid visitors/staff accessing unit when unwell

HAND HYGIENE

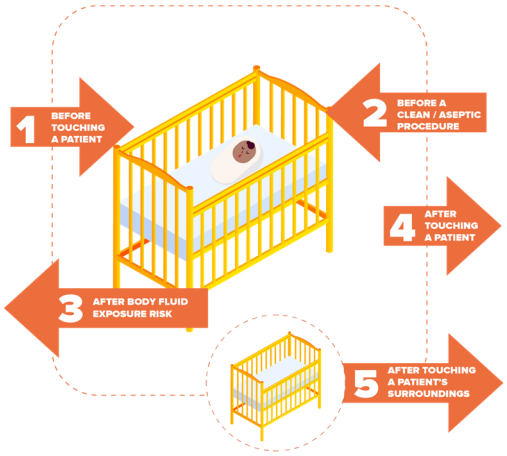
- Describes decontamination of hands using soap and water, antiseptic wash or alcohol hand rub solution
- Good hand hygiene is the most effective way to prevent spread of infection
- Use this safe method of working at all times to protect staff, patients and others from infection
- All practitioners are personally accountable for their hand hygiene practice, and for the decontamination of all re-usable equipment that they touch and use in clinical practice

ASSESSMENT OF NEED TO DECONTAMINATE HANDS

***Hands must be decontaminated at critical points before, during and after patient care to prevent cross-infection of micro-organisms – see World Health Organization (WHO)* 5 moments for hand hygiene**

- Hand decontamination must be carried out at the following 5 moments of care regardless of whether or not gloves have been worn
- before touching a patient
- before and after aseptic non-touch technique (ANTT)/aseptic procedure
- after body fluid exposure
- after touching a patient
- after touching patient surroundings

Figure 1: Five moments for hand hygiene



- Hands must also be decontaminated
- on arrival at and before leaving ward/department
- after visiting the toilet
- before serving/preparing feeds
- after any activity or contact that potentially results in hands becoming contaminated
- on entering and leaving an isolation cubicle
- after removing personal protective equipment

CHOICE OF HAND HYGIENE PREPARATIONS

- Alcohol based hand rub (ABHR) is an effective method of hand decontamination on visibly clean hands but is not recommended when hands are visibly dirty

INFECTION PREVENTION • 2/3

Alcohol hand rub alone must not be used after caring for patients (or their equipment/environment) with suspected or known infectious diarrhoea e.g. C. difficile or Norovirus, regardless of whether gloves are worn

- Hand washing with liquid soap and water removes dirt, organic matter and transient flora by mechanical action, and is to be used:
  - when hands are visibly dirty/visibly soiled with body fluids or other organic matter
  - when caring for patients with:
    - suspected or confirmed diarrhoea and/or vomiting
    - *C. difficile*/Norovirus and during outbreaks of these organisms on wards/in bays
  - after several consecutive applications of ABHR
  - after visiting the toilet
- Liquid soap alone does not provide sufficient hand disinfection before invasive procedures and surgery
- WHO guidelines recommend use of ABHR for 20–30 sec or use of soap and water for 40–60 sec

DRESS CODE

- Bare below elbow for all staff working within clinical areas (e.g. no sleeves below elbow, no wrist watches, wrist jewellery or plaster casts/wrist splints)
- Do not wear false nails, nail extensions, gel nails or nail varnish
- Keep nails short and clean
- No stoned rings (acceptable to wear a plain wedding band)
- Long hair tied back or up

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Aprons

- <2 metres of child with respiratory tract infection
- Contact with infectious materials or equipment anticipated
- Using hazardous chemicals
- ANTT – see below

Gloves (non-sterile)

- Contact with respiratory secretions or other infectious material of contaminated surfaces
- ANTT – see below
- Single patient use; new gloves and apron for every procedure
- Take gloves and apron off at point of use and clean hands
- Do not carry gloves in your pocket
- Do not use ABHR on gloves

Remove gloves and aprons as soon as clinical activity completed, before touching pens, notes, phone, computer etc.

Sterile gloves and gown

- For central venous line (CVL) including peripheral long line (PICC)
- Sterile gloves for ANTT if touching key parts/key sites

Masks

- Surgical face mask
  - <2 metres of child with respiratory tract infection
- FFP3 mask (fit-tested)
  - aerosol generating procedure (e.g. intubation, CPAP, HFNC, suctioning of lower respiratory tract, bag mask ventilation) with respiratory tract infection and when advised by infection prevention team
  - in conjunction with eye protection when increased risk of splashing of body fluids into eyes/nose/mouth

Eye protection

- <2 metres of child with persistent coughing or sneezing
- When increased risk of splashing of body fluids into eyes
- If increased risk of organism transmitted through conjunctiva (e.g. SARS CoV-2)

SURGICAL ANTT

- See local ANTT guidelines

Definition

- Essential procedure aimed at protecting patients from infection during invasive procedures, including central venous catheter insertions, (long lines, UVC, or UACs)
- Achieved by minimising presence of pathogenic micro-organisms as is practically possible
- Specific type of aseptic technique with a unique theory and practice framework, providing core principles for safe aseptic technique and a standardised approach to assessing and applying safe aseptic technique to any invasive clinical procedure
- Do not touch and protect 'key parts' or 'key sites' e.g. use caps and covers for end of syringes/needles

Preparation phase

- Decontaminate hands
- Decontaminate tray/trolley using Trust approved disinfectant
- Clean hands
- PPE (as above)
- Prepare and assemble equipment using a non-touch technique. Protect key parts at all times by not touching
- Remove gloves and decontaminate hands

Patient phase

- Decontaminate hands at point of care
- Apply appropriate PPE. Non-sterile gloves if not touching key parts (e.g. IV drug administration, venepuncture/cannulation), sterile gloves if touching key parts (e.g. urinary catheterisation, central line/PICC insertion)
- Prepare all equipment using a non-touch technique, protecting key parts at all times by not touching them
- Decontaminate key parts/key sites using single use chlorhexidine 2% in alcohol 70% (SEPP/FREPP or ChloraPrep® 3 mL) and allow drying for 30 sec
- Be aware of possible burns or contact dermatitis with use of alcohol based preparations in preterm babies or those with non-intact contact skin
- Use of povidone-iodine preferred as skin preparation for blood cultures
- Perform procedure, ensuring protection of key parts/sites at all times

Decontamination phase

- Dispose of sharps into sharps box immediately at point of use
- Remove PPE at bedside
- Dispose of all equipment as clinical waste in nearest clinical waste bin, return equipment to clinical room ensuring it is cleaned with detergent wipes
- Decontaminate hands

INGUINAL HERNIA ● 1/1

INTRODUCTION

- Incidence: 0.5–1% in term babies and 5–10% in premature babies
- Right-sided in 50% of cases, left-sided in 10% and both sides in 40%
- Most cases can be managed with elective surgery before or shortly after discharge from NNU
- Manage incarcerated hernia as a surgical emergency

CLINICAL FEATURES

- Visible swelling or bulge in inguino-scrotal region in boys, inguino-labial region in girls. May be constant or intermittent, becoming more prominent with crying or straining

Simple inguinal hernia

- Often painless, but many babies happier after repair
- Oxygen requirements may fall after repair

Incarcerated inguinal hernia

- Generally presents with a tender firm mass in the inguinal canal or scrotum
- Swelling can be surprisingly small
- Baby may be fussy, unwilling to feed and crying inconsolably
- Overlying skin may be oedematous, erythematous and discoloured
- May be associated abdominal distension, with/without bilious vomiting
- Arrange emergency surgical referral

MANAGEMENT AND REFERRAL

Reducible inguinal hernia

- If asymptomatic, refer by letter to surgeon. Include likely date of discharge and parents' contact details
- Inform parents of the risk of hernia becoming incarcerated
- if baby develops a tense, painful swelling and is in obvious pain, parents should seek **immediate** medical advice
- if swelling not reduced ≤2 hr, complications may arise (bowel compromise – later testicular atrophy)

Incarcerated inguinal hernia

- Stabilise baby
- Administer analgesia (morphine IV), then gently try to reduce hernia
- If fully reduced, arrange elective inguinal hernia repair before discharge. Refer to paediatric surgical team for elective review
- If not reducible, request urgent help from on-call paediatrician/neonatologist
- Keep child nil-by-mouth
- Insert large bore nasogastric tube (NGT), empty stomach and leave on free drainage (see **Nasogastric tube insertion** guideline)
- Obtain IV access and send blood for FBC and U&E
- Start maintenance IV fluids
- Aspirate NGT 4-hrly in addition to free drainage and replace aspirate volume, mL-for-mL with sodium chloride 0.9% with 10 mmol potassium chloride in 500 mL IV. Leave NGT on free drainage
- If hernia remains irreducible, refer urgently for surgical assessment
- Complete detailed transfer letter using **BadgerNet** system. Ensure parental details and telephone contact numbers included
- If possible, ask parents to travel to planned place of surgery to meet with surgical team

WHILE AWAITING TRANSFER TO SURGICAL UNIT

- Reassess baby regularly
- Monitor fluid balance, blood gases, glucose and consider need for fluid resuscitation

USEFUL INFORMATION

- https://bwc.nhs.uk/download.cfm?doc=docm93jijm4n1200
- http://www.e-lfh.org.uk/programmes/paediatric-surgery/

INHERITED METABOLIC DISORDERS (IMD) ● 1/4

RECOGNITION

- Early recognition of IMD and prompt management are essential to prevent death or neurodisability
- diagnosis of IMD in babies is often delayed owing to non-specific nature of clinical presentation and unfamiliarity with diagnostic tests
- seek early advice from regional clinical IMD team at tertiary metabolic centre

Consider IMD at the same time as common acquired conditions, such as sepsis

Differential diagnosis (lists below are not comprehensive, discuss with clinical IMD team)

Presentation	Common conditions
• Encephalopathy without metabolic acidosis	• Urea cycle disorders • Maple syrup urine disease (MSUD)
• Encephalopathy with metabolic acidosis	• Organic acidaemias (e.g. propionic, methylmalonic, isovaleric, glutaric aciduria Type I) • Congenital lactic acidosis
• Liver dysfunction including jaundice, particularly conjugated	• Galactosaemia • Tyrosinaemia • Neonatal haemochromatosis • Alpha-1 antitrypsin deficiency • Citrin deficiency • Niemann-Pick disease type C • Mitochondrial disease • Congenital disorders of glycosylation – CDG 1b (uncommon)
• Hypoglycaemia	• Hyperinsulinism • Fatty acid oxidation disorders • Glycogen storage disorders • Gluconeogenesis defects
• Metabolic acidosis	• Organic acidaemias • Congenital lactic acidosis
• Non-immune hydrops	• Lysosomal storage disorders, including: ◦ mucopolysaccharidoses ◦ I-cell disease ◦ Gaucher disease ◦ Niemann-Pick disease type A, B or C
• Severe neonatal hypotonia	• Zellweger's syndrome • Non-ketotic hyperglycinaemia (NKHG)
• Cataracts	• Galactosaemia • Zellweger's syndrome • Lowe's syndrome
• Congenital anomalies ◦ if developmental delay or neurological signs present with dysmorphism, consider IMD	
• Apnoea or periodic breathing in term baby • Hiccoughing	• NKHG (also likely to have hypotonia, epileptic encephalopathy) • MSUD
• Respiratory alkalosis in a tachypnoeic baby	• Hyperammonaemia
• Intractable neonatal seizures	• Pyridoxine or pyridoxal phosphate–responsive seizures • Peroxisomal biogenesis disorders • Neurotransmitter disorders • Glucose transporter defect (GLUT 1) • NKHG • Sulphite oxidase deficiency and molybdenum cofactor deficiency • Serine synthesis defect

Specific indicators

Clinical context

- Unexplained and mysterious deterioration of baby (can be as short as 12 hr but more commonly after a symptom-free interval of 24 hr–14 days)

Family history

- Known metabolic disorders
- Unexplained neonatal or infant deaths
- Parental consanguinity

Obstetric history (current pregnancy)

- Acute fatty liver of pregnancy or HELLP syndrome may indicate a long chain fatty acid oxidation defect in the fetus. Test baby with plasma/blood spot acylcarnitines soon after birth

Non-specific indicators suggestive of metabolic disorder in an encephalopathic baby

- Encephalopathy in low-risk baby, or onset after period of normality
- Fluctuating consciousness and muscle tone
- Changes in muscle tone:
  - axial hypotonia with limb hypertonia
  - 'normal' tone in comatose baby
- Abnormal movements:
  - myoclonic or boxing movements
  - tongue thrusting
  - lip smacking
  - unexplained seizures/burst suppression/hypsarrythmia
  - seizures are uncommon or occur late in babies with metabolic encephalopathy compared to hypoxic-ischaemic encephalopathy

INITIAL INVESTIGATIONS

- Whenever IMD suspected, perform required investigations **without delay**
  - in a sick child request urgent processing of investigations by metabolic biochemistry laboratory
- Seek early advice about appropriate investigations and management from IMD team at tertiary metabolic centre

Urine

- Smell
- Ketostix: presence of large amounts of urinary ketones is usually abnormal in babies and could suggest IMD, especially organic acidaemias
- Freeze 15–20 mL urine for amino and organic acid analysis
- Metabolic screen (amino acids, organic acids, ketones, sugars)

Blood

- FBC, U&E, infection screen
- Glucose
- Blood gas (calculate anion gap)
- Ammonia
- Lactate
- Acylcarnitines, including free and total carnitine (bloodspot on Guthrie card/2 mL Li-Hep)
- Plasma amino acids (lithium heparin 2 mL)

Imaging

- Cranial ultrasound scan
- Ophthalmic examination

SPECIFIC INVESTIGATIONS

Discuss with clinical IMD team at tertiary metabolic centre before initiating specific investigations as not all tests may be indicated in all babies with similar presentation

Unexplained/prolonged jaundice or liver synthetic dysfunction

Blood

- Galactosaemia screen [galactose-1-phosphate uridyltransferase (GALIPUT)/Beutler test] (urinary reducing substances can be negative after short period of galactose exclusion)
  - cannot be performed reliably if transfused ≤90 days: measure galactose-1-phosphate (Gal-1-P) and urine galactitol (urine organic acids)
- Total and conjugated bilirubin, liver function tests, including clotting studies
- Blood spot – succinylacetone (tyrosinaemia I)
- Ferritin
- Plasma – very long chain fatty acids only if dysmorphic and hypotonic*
- Plasma quantitative amino acids
- Alpha-1 antitrypsin (quantitative)
- Transferrin isoelectric focusing* (CDG)
- Consider Niemann-Pick disease type C (chitotriosidase, DNA-mutation analysis)*

Urine

- Organic acids (succinylacetone in tyrosinaemia I)
- Reducing substances: use Clinitest™
  - urinary dipsticks are glucose specific and miss galactose in babies with galactosaemia
  - negative Clinitest™ does not exclude galactosaemia

Encephalopathy/epileptic encephalopathy/neonatal intractable seizures

Discuss with IMD team – some of the following investigations may be advised and a trial of treatment with pyridoxine/pyridoxal phosphate may be required in certain cases

- Urgent quantitative plasma amino acids and urine amino acids
- Paired blood and CSF amino acids (glycine, serine), (NKHG, serine synthesis deficiency)
  - CSF glucose, lactate (GLUT 1, mitochondrial disorder). Paired blood and CSF lactate with blood sample taken before CSF
- Plasma – very long chain fatty acids (peroxisomal disorder)
- Urine:
  - dipstick for ketones
  - sulphite test for sulphite oxidase deficiency
- Plasma – uric acid (low in molybdenum cofactor deficiency)
- Pyridoxine responsive epilepsy (antiquitin deficiency)
- Pyridoxal phosphate-responsive seizures
  - consider CSF amino acids, CSF neurotransmitters, urine organic acid analysis
  - urine alpha-aminoadipic semialdehyde (AASA) (freeze urine and CSF samples **immediately**)

Hypoglycaemia (most informative when obtained at time of hypoglycaemia)

- Plasma non-esterified free fatty acids (FFA)
- Beta-hydroxybutyrate (ketones)
- Insulin and C-peptide
- Acylcarnitine profile, free and total carnitine
- Cortisol, growth hormone
- Urine for organic acids and ketones

Post-mortem (plan how best to use these precious samples in consultation with IMD team)

- Plasma (2–5 mL), urine (10–20 mL) and CSF (1 mL) frozen at −20°C
- Red cells: blood (5 mL) in lithium heparin stored at 4°C (fridge)
- Blood (5 mL) in EDTA: stored at 4°C (fridge) for DNA analysis
- Tissue biopsies
  - skin: store in viral culture medium or sodium chloride 0.9% at 4°C (fridge) (see **Skin biopsy** guideline)
  - muscle and liver: take within 1 hr of death, snap freeze in liquid nitrogen
- Bile for acylcarnitine analysis – stable for longer than other body fluids

IMMEDIATE MANAGEMENT

Commence emergency management of suspected IMD while awaiting results of initial investigations and discuss with IMD team as early as possible

- Attend to **A**irway, **B**reathing and **C**irculation; ventilate if necessary
- Omit all protein, fat and galactose/lactose (milk) intake – do not give PN or parenteral lipid
- Commence glucose 10% IV infusion to provide 6–8 mg glucose/kg/min
  - if hyperglycaemic (>15 mmol/L) or catabolic, start insulin infusion, under guidance from IMD team
  - if hypertonic (concentration of glucose >10%) infusion necessary, insert central line [see **Long line (peripherally sited)** guideline]
- Correct dehydration, acid-base and electrolyte disturbances
- Cover for infection
- Control seizures (avoid sodium valproate)
- When stable and appropriate, consider early transfer to tertiary metabolic centre

SPECIFIC MANAGEMENT

- Must be led by IMD team
- Use following as guide to general principles of management
- Check regularly that metabolic emergency medications mentioned below are in stock and available for emergency use

Neonatal hyperammonaemia

Medical emergency requiring prompt intervention to lower ammonia concentration

- Renal replacement therapy (haemofiltration more efficient than peritoneal dialysis)
- Sodium benzoate
- Sodium phenylbutyrate
- L-arginine
- Carglumic acid (Carbaglu®)

Organic acidaemia

- Reduce/stop protein intake
- Glucose 10% infusion +/- insulin
- L-carnitine
- Carglumic acid (Carbaglu®)

Fatty acid oxidation disorders

- Avoid prolonged fast
- Specific management guided by IMD team

Lactic acidosis

- Dichloroacetate
- Biotin
- L-carnitine
- Thiamine

Galactosaemia

- Dietary exclusion of galactose

For further information on IMD, www.bimdg.org.uk/guidelines.asp, Emergency protocols and follow through

LOCAL CONTACT

- Birmingham Children's Hospital metabolic team (0121 333 9999)

INTRA-ABDOMINAL CYSTS • 1/2

INTRODUCTION

This guideline does not apply to cystic structures which may be arising from the urinary tract

- Antenatally detected intra-abdominal cysts include:
  - ovarian
  - intestinal duplication
  - mesenteric
  - vitello-intestinal

SYMPTOMS AND SIGNS

- Most cysts will be asymptomatic but the following can be present:
  - abdominal pain
  - vomiting
  - abdominal distension
  - respiratory compromise
  - rectal bleeding
- Meconium pseudocyst may also be detected on an antenatal ultrasound. They will nearly always cause vomiting and abdominal distension and may be associated with underlying diagnosis of cystic fibrosis

MANAGEMENT

Antenatal

- Refer to/discuss appropriate place for delivery with fetal medicine unit
- Refer to paediatric surgeon for antenatal counselling

Delivery

- In most cases, obstetric management will not alter

Postnatal

- Resuscitate baby as normal
- Once stable, perform full postnatal physical examination (see **Examination of the newborn** guideline)

Meconium pseudocyst

- If suspected antenatally, do not feed baby at birth
- Insert size 8 Fr nasogastric tube (NGT) immediately after birth and fix securely with tape (see **Nasogastric tube insertion** guideline)
- Empty stomach by aspirating NGT with a 10 or 20 mL syringe
  - if <20 mL aspirated, check position of tube
- Place NGT on free drainage by connecting to a bile bag
- Once stabilised, admit baby to NNU
- Replace nasogastric losses, mL-for-mL, using sodium chloride 0.9% with potassium chloride 10 mmol/500 mL IV
- Commence IV maintenance fluids (see **Intravenous fluid therapy** guideline)
- On day of birth, refer to on-call surgical team at planned place of surgery

Other types of intra-abdominal cyst

- Unless significant abdominal distension present following birth, allow baby to feed normally and observe in postnatal ward for ≥48 hr
- If baby well after 48 hr with no abdominal symptoms and feeding normally then discharge
- Arrange outpatient abdominal ultrasound scan ≤1 week of birth
- Consider sacrococcygeal teratoma (SCT) – could be entirely intra-abdominal and arising from pelvis, in which case discuss with paediatric surgeon

SURGICAL REFERRAL

- Urgency will depend on clinical situation
- **Meconium pseudocyst:**
  - manage as above and refer to surgeon on day of birth
- **Symptomatic cyst:**
  - stabilise on NNU and refer to on-call surgical team on day of presentation
- **Asymptomatic cyst:**
  - abdominal ultrasound ≤1 week of birth

INTRA-ABDOMINAL CYSTS ● 2/2

- when result known, written outpatient referral to consultant paediatric surgeon
- if arising from pelvis consider SCT and discuss with paediatric surgeon
- **Resolved cyst:**
- ultrasound ≤1 week of birth, even if cyst appears to have resolved during pregnancy. Arrange outpatient surgical referral

USEFUL INFORMATION

- http://www.e-lfh.org.uk/programmes/paediatric-surgery/

INDICATIONS

- Severely ill baby when immediate vascular access needed, a UVC is not feasible and peripheral access not possible (maximum 2 attempts)
- Cardiac arrest
- allows rapid expansion of circulating volume
- gives time to obtain IV access and facilitates procedure by increasing venous filling

CONTRAINDICATIONS

- Fractures in target bone
- Previous orthopaedic surgery near insertion site
- Previous IO insertion in target bone within the preceding 48 hr
- At insertion site:
- infection
- loss of skin integrity
- inability to locate landmarks or excessive tissue
- Osteogenesis imperfecta (if using a manual Cook needle only)

EQUIPMENT

- EZ-IO drill and needles (3–39 kg: 15 mm pink) or Cook needle
- <3 kg use 18–21 G butterfly needle
- 5 mL syringe with extension and 3-way tap to aspirate and confirm correct position
- 10 mL sodium chloride 0.9% flush
- 20 mL syringe to administer fluid boluses
- Infusion fluid
- Lidocaine 1%

PROCEDURE

Never place your/assistant's hand under tibia during insertion to avoid staff injury

EZ-IO

1. Locate landmarks – anteromedial surface of the tibia, 1 cm below anterior tibial tuberosity
2. Aseptic non-touch technique: clean site
3. If conscious administer local anaesthetic, 3 mg/kg (equivalent to 0.3 mL/kg) lidocaine 1% (preservative free) subcutaneously
4. Choose short pink hub needle and attach to drill magnetically
5. Hold drill and needle at 90° to skin surface and push through skin without drilling, until bone is felt
6. Push drill button and drill continuously and push until there is loss of resistance – there is a palpable give as needle breaches the cortex
7. Remove drill and unscrew trocar
8. If possible aspirate the marrow
9. Secure needle (with EZ-IO fixator if available)
10. Attach pre-prepared connection tube
11. If awake, give lidocaine 1% (preservative free) 0.5 mg/kg (0.05 mL/kg) over 2 min through IO, leave 1 min then flush with sodium chloride 0.9% 2 mL
12. Proceed with required therapy
13. If EZ-IO drill power fails, repeated clockwise-anticlockwise twisting with gentle pressure allows manual insertion
14. Place wristband on any limbs IO insertion attempted/successful to highlight limb not to be used for further attempts in next 48 hr

Cook needle

1. Locate landmarks – anteromedial surface of the tibia, 1 cm below anterior tibial tuberosity
2. Aseptic non-touch technique: clean site
3. If conscious administer local anaesthetic, 3 mg/kg (equivalent to 0.3 mL/kg) lidocaine 1% (preservative free)
4. Stabilise the lower limb laterally, insert needle at 90° to skin surface. Direct needle caudally from the epiphyseal plate at an angle of approximately 60° to the long axis of the tibia

5. Advance needle firmly; needle entry into the marrow cavity is accompanied by a loss of resistance, sustained erect posture of the needle without support and free fluid infusion
6. Attach 5 mL syringe and confirm correct position by aspirating marrow (may be omitted in patients with circulatory arrest), take any bloods required
7. Infuse fluid using 20 mL syringe and IV cannula extension set (with Leur-lock ends)
8. Secure IO cannula with sterile dressing
9. Place wristband on any limbs where IO insertion attempted/successful to highlight limb not to be used for further attempts in the next 48 hr

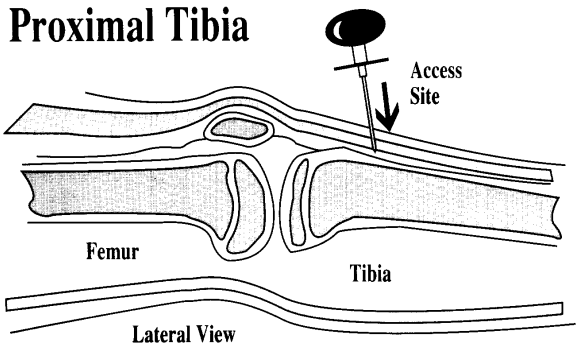
Preferred site

Avoid fractured bones and limbs with fractures proximal to possible sites

Proximal tibia

- Identify anteromedial surface of tibia approximately 1 cm below tibial tuberosity
- Direct needle away from knee at approximately 90° to long axis of tibia

Access site on proximal tibia – lateral view



COMPLICATIONS

Infrequent (<1%) and include:

- Bleeding
- Infection
- revert to central or peripheral venous access as soon as possible
- Extravasation
- Subperiosteal infusion
- Bone marrow embolism
- Dislodgement
- Skin necrosis
- Compartment syndrome
- observe and measure limb circumference regularly
- palpate distal pulses and assess perfusion distal to IO access site
- Pain from rapid infusion: give lidocaine 1% (preservative free) 0.5 mg/kg (0.05 mL/kg) over 5 min

DOCUMENTATION

Must include:

- Indication for IO
- If analgesia used
- Insertion site
- Number of attempts (successful/unsuccessful) and location of attempts
- Confirm wristband applied to limb where IO was attempted/successfully inserted to highlight not to be used for further attempts in next 48 hr
- Any complications with procedure
- Batch number of IO needle
- Update parents/carers

INTRAVENOUS FLUID THERAPY ● 1/5

PRINCIPLES

- Postnatal physiological weight loss is approximately 5–10% in first week after birth
- Preterm babies have more total body water and may lose 10–15% of their weight in first week after birth
- Postnatal diuresis is delayed in respiratory distress syndrome and in babies who had significant intrapartum stress
- Preterm babies have limited capacity to excrete sodium in first 48 hr
- Sodium chloride 0.9% contributes a significant chloride (Cl^-) load which can exacerbate metabolic acidosis
- Liberal sodium and water intake before onset of natural diuresis is associated with increased incidence of patent ductus arteriosus, necrotising enterocolitis and chronic lung disease
- After diuresis, a positive sodium balance is necessary for tissue growth
- Preterm babies, especially if born <29 weeks' gestation, lose excessive sodium through immature kidneys
- Babies <28 weeks have significant transepidermal water (TEW) loss
- TEW loss leads to hypothermia, loss of calories and dehydration, and causes excessive weight loss and hypernatraemia

MONITORING

Weigh

- On admission
- Daily for intensive care babies: twice daily if fluid balance is a problem
- use in-line scales if available

Serum sodium

- Daily for intensive care babies
- **Serum**
- admission electrolytes reflect maternal status: need not be acted upon but help to interpret trends

Serum creatinine

- Daily for intensive care babies
- Reflects renal function over longer term
- trend is most useful
- tends to rise over first 2–3 days
- gradually falls over subsequent weeks
- absence of postnatal drop is significant

Serum urea

- Not useful in monitoring fluid balance; reflects nutritional status and nitrogen load

Urine output

- All babies undergo diuresis during first 2–3 days of life. Strict input/output to be measured until urine output normalises
- Review 8-hrly for intensive care babies
- 2–4 mL/kg/hr normal hydration
- <1 mL/kg/hr requires investigation except in first 24 hr after birth
- >6–7 mL/kg/hr suggests impaired concentrating ability or excess fluids

NORMAL REQUIREMENTS

Humidification

- If <29 weeks, humidify incubator to ≥60%
- If ventilated or on CPAP ventilator, set humidifier at 39°C negative 2 to ensure maximal humidification of inspired gas

Normal fluid volume requirements

	Fluid volume (mL/kg/day)	
Day of life	<1000 g	≥1000 g
1	90	60
2	120	90
3	150	120
4	150	150

- **Day 1**
  - glucose 10%
  - if birth weight <1000 g or 1001–1500 g and baby not anticipated to reach 100 mL/kg/day enterally by day 5, start parenteral nutrition (PN) (see **Parenteral nutrition** guideline)
- **Day 2**
  - glucose 10% and potassium 10 mmol in 500 mL (depending on electrolyte results) or PN
  - use sodium chloride 0.45% in arterial line fluids
  - add sodium only when there is diuresis, or weight loss >6% of birth weight
- **Day 3**
  - glucose 10%, sodium chloride 0.18% and potassium 10 mmol in 500 mL or PN (with potassium 2 mmol/kg/day and sodium 4 mmol/kg/day)
- **After day 4**
  - glucose 10% (with maintenance electrolytes adjusted according to daily U&E) or PN
- Fluid volume requirements are a guide and can be increased faster or slower depending on serum sodium values, urine output and changes in weight
- Fluid volume for extreme preterm babies:
  - consider clinical context
  - monitor above parameters closely
- Babies receiving phototherapy may require extra fluids depending on type of phototherapy

HYPONATRAEMIA (<130 mmol/L)

- Response to treatment should be proportionate to degree of hyponatraemia.
- May cause hypotonia and apnoea. If acute and severe (<120 mmol/L) is associated with cerebral oedema and seizures

Causes

Excessive free water

- Reflection of maternal electrolyte status in first 24 hr
- Failure to excrete fetal extracellular fluid will lead to oedema without weight gain
- Water overload: diagnose clinically by oedema and weight gain
- Excessive IV fluids
- Inappropriate secretion of ADH in babies following major cerebral insults, or with severe lung disease
  - treatment with indometacin or ibuprofen

Excessive losses

- Prematurity (most common cause after aged 48 hr)
- Adrenal insufficiency
- GI losses
- Diuretic therapy (older babies)
- Inherited renal tubular disorders

Inadequate intake

- Preterm breastfed babies aged >7 days

Management depends on cause

Excessive IV fluids and failure to excrete fetal ECF

Management

- Reduce fluid intake to 75% of expected

Inappropriate ADH
Clinical features
- Weight gain, oedema, poor urine output
- Serum osmolality low (<275 mOsm/kg) with urine not maximally dilute (osmolality >100 mOsm/kg)

Management
- Reduce fluid intake to 75% of expected
- Consider sodium infusion only if serum sodium <120 mmol/L

Risk of accidental hypernatraemia when using sodium chloride 30%. Use with caution and always dilute before use

Acute renal failure
Management
- Reduce intake to match insensible losses + urine output
- Seek advice from tier 2 staff/consultant

Excessive renal sodium losses
Management

If possible, stop medication (diuretics, caffeine) that causes excess losses

- Check urinary electrolytes
- Calculate fractional excretion of sodium (FE Na^+ %):
- FE Na^+ = [(urine Na × plasma creatinine)/(urine creatinine × plasma Na)] × 100
- normally <1% but in sick preterm babies can be up to 10%
- affected by sodium intake: increased intake leads to increased fractional clearance
- if >1%, give sodium supplements
- Calculate sodium deficit
- = (135 − plasma sodium) × 0.6 × weight in kg
- replace over 24 hr unless sodium <120 mmol/L or symptomatic (apnoea, fits, irritability)
- initial treatment should bring serum sodium up to approximately 125 mmol/L
- Use sodium chloride 30% (5 mmol/mL) diluted in maintenance fluids. Ensure bag is mixed well before administration
- See **Renal failure** guideline

Adrenal insufficiency
Clinical features
- Hyperkalaemia
- Excessive weight loss
- Virilisation of females
- Increased pigmentation of both sexes
- Ambiguous genitalia

Management
- Seek consultant advice

Inadequate intake
Clinical features
- Poor weight gain and decreased urinary sodium

Management
- Give increased sodium supplementation
- If receiving diuretics, stop or reduce dose

Excessive sodium intake leading to water retention
Clinical features
- Inappropriate weight gain

Management
- Reduce sodium intake

Treatment of acute symptomatic hyponatraemia with seizures

- Do not manage hyponatraemic encephalopathy using fluid restriction alone
- Give sodium chloride 2.7% 2 mL/kg IV via a central line over 10–15 min
- If symptoms still present, repeat
- Measure serum sodium hourly until symptoms resolve
- when symptoms resolved, ensure serum sodium does not increase by >12 mmol/L/24 hr

HYPERNATRAEMIA (>145 mmol/L)

Prevention

- Prevent high TEW loss
- use plastic wrap to cover babies of <32 weeks' gestation at birth
- nurse in high ambient humidity >80%
- use bubble wrap
- minimise interventions
- humidify ventilator gases

Causes

- Water loss (most commonly)
- TEW
- glycosuria
- Excessive sodium intake
- sodium bicarbonate
- repeated boluses of sodium chloride
- congenital hyperaldosteronism/diabetes insipidus (very rare)

Management depends on cause

Hypernatraemia resulting from water loss

Clinical features

- Leads to weight loss with hypernatraemia

Management

- Increase fluid intake and monitor serum sodium

Osmotic diuresis

Management

- Treat hyperglycaemia with an insulin infusion (see **Hyperglycaemia** guideline)
- Rehydrate with sodium chloride 0.9%

Hypernatraemia resulting from excessive intake

Management

- If acidosis requires treatment, use THAM (trometamol) instead of sodium bicarbonate
- Reduce sodium intake
- Change arterial line fluid to sodium chloride 0.45%
- Minimise number and volume of flushes of IA and IV lines

USING SYRINGE OR VOLUMATIC PUMP TO ADMINISTER IV FLUIDS

- Do not leave bag of fluid connected (blood components excepted)
- Nurse to check hourly:
- infusion rate
- infusion equipment
- site of infusion
- Before removing giving set, close all clamps and switch off pump

IV FLUIDS

Useful information

- Percentage solution = grams in 100 mL (e.g. glucose 10% = 10 g in 100 mL)
- 1 millimole = molecular weight in milligrams

Compositions of commonly available solutions

Fluid	Na mmol/L	K mmol/L	Cl mmol/L	Energy kcal/L
Sodium chloride 0.9% (iso-osmolar, isotonic)	150	-	150	-
Glucose 10% (hyperosmolar, hypotonic)	-	-	-	400
Glucose 10%/sodium chloride 0.18% (hyperosmolar, hypotonic)	30	-	30	400
Albumin 4.5%	150	1	-	-
Sodium chloride 0.45%	75	-	75	-

Useful figures

- Sodium chloride 30% = 5.13 mmol/mL each of Na and Cl
- Sodium chloride 0.9% = 0.154 mmol/mL each of Na and Cl
- Potassium chloride 15% = 2 mmol/mL each of K and Cl
- Calcium gluconate 10% = 0.225 mmol/mL of Ca
- Sodium bicarbonate 8.4% = 1 mmol/mL each of Na and bicarbonate
- Sodium chloride 0.9% 1 mL/hr = 3.7 mmol Na in 24 hr

Osmolality

- Serum osmolality = 2(Na + K) + glucose + urea (normally 285–295 mOsmol/kg)
- Anion gap = $(Na^+ + K^+) - (Cl^- + HCO_3^-)$ normally 7–17 mmol/L
- Normal urine: osmolality 100–300 mOsmol/kg, specific gravity 1004–1015
- Babies can dilute urine up to 100 mOsmol/kg, but can concentrate only up to 700 mOsmol/kg

INTUBATION ● 1/3

See also **Intubation – difficult** guideline and Newborn Life Support guidelines 2021 – see https://www.resus.org.uk/library/2021-resuscitation-guidelines/newborn-resuscitation-and-support-transition-infants-birth

This procedure must be undertaken or supervised by an experienced person
Do not attempt to carry out procedure unsupervised unless you have demonstrated your competence

ELECTIVE ORAL INTUBATION

- Use premedication as per local unit policy
- Good practice to have team around the baby familiar with each other's names and assigned roles for the intubation procedure (e.g. team leader with oversight, medication, equipment) using pre-intubation checklist

Equipment

- Suction
- Oxygen with pressure limiting device and T-piece or 500 mL bag and appropriate size face mask
- Endotracheal tube (ETT); non cuffed; 3 sizes (diameter in mm):

Weight of baby (g)	ETT
<1000–1250	2.5
>1250–3000	3.0
>3000	3.5–4.0

- ETT introducer/stylet
- Syringe and needles for drawing up premedication
- Neonatal stethoscope
- Hat for baby to secure tube, ETT fixing device and scissors
- Laryngoscope handle and Miller blades sizes 1, 0 and 00, stethoscope, oropharyngeal airway
- Videolaryngoscope (if available)
- Pedicap® end tidal CO_2 detector
- Oxygen blender

Preparation

- Ensure cannula in place and working
- Ensure laryngoscope is working, correct sized blades are available and T-piece system is working. Set pressure limits: 30 cm H_2O for term babies and 20–25 cm H_2O in preterm babies
- Check you have the correct ETT size and attachments to secure ETT
- Insert ETT introducer into ETT ensuring it does not protrude past end of ETT
- Ensure all drugs drawn up, checked, labelled and ready to give
- Check no contraindications to drugs
- Ensure monitoring equipment attached and working reliably
- If nasogastric tube (NGT) in place, aspirate stomach (particularly important if baby has been given enteral feeds)
- Ensure back-up plan in case intubation does not work (see **Intubation – difficult** guideline, use of supraglottic airway devices (LMA or i-gel) and Newborn Life Support guidelines 2021 (https://www.resus.org.uk/library/2021-resuscitation-guidelines/newborn-resuscitation-and-support-transition-infants-birth)

Premedication

- Use blended oxygen to pre-oxygenate for 2 min before drug administration
- start with room air and increase FiO_2 to get SpO_2 to target range appropriate for gestational age (see **Oxygen saturation targets** guideline). Avoid hyperoxia in preterm baby
- Continue to pre-oxygenate until laryngoscopy and between attempts

Drugs

Choice of drugs depends on local practice
Analgesia and muscle relaxation can improve likelihood of successful intubation
Discuss vagolytics (atropine) to prevent bradycardia during laryngoscopy with consultant

Muscle relaxants

Administer muscle relaxants only if you are confident that the team can intubate baby quickly, mask ventilation can be maintained, and the baby does not have a severely abnormal airway
Do not use a muscle relaxant unless adequate analgesia has been given

PROCEDURE

- Give premedication
- Use mask ventilation in neutral position, a shoulder roll may help
- Place laryngoscope in right side of mouth, lift up tongue and jaw to view cords and larynx. Lift laryngoscope; do not tilt
- Avoid trauma to gums
- View vocal cords on monitor while using videolaryngoscope
- Cricoid pressure by person intubating or an assistant
- Suction secretions only if they are blocking the view as this can stimulate the vagal nerve and cause bradycardia and vocal cord spasm
- Insert ETT
- Advance ETT to desired length at lips
- General recommendation is to advance ETT no further than end of black mark at end of tube (2.5 cm beyond cords), but this length is far too long for extremely preterm babies
- See **Table: Length of ETT** for where approximate markings of ETT should be at lips

Table: Length of ETT

Gestation of baby	Actual weight of baby (kg)	Length of ETT (cm) at lips
22–24	0.4–0.6	5.5
25–26	0.7–0.8	6.0
27–29	0.9–1.0	6.5
30–32	1.1–1.4	7.0
33–34	1.5–1.8	7.5
35–37	1.9–2.4	8.0
38–40	2.5–3.1	8.5
41–43	3.2–4.2	9.0

- Remove stylet if used before confirming ETT position

Confirming position of ETT

- View ETT passing through larynx
- Observe for chest movements with ventilation breaths
- Use an end tidal CO_2 detector attached to ETT for verification of correct tube placement
  - may be of limited value in very small baby or in the presence of cardiovascular collapse. In these cases, lack of colour change may not always mean tube is not in the correct position (colour change is dependent on circulation and adequate volume of gas exchange)
- Auscultate both axillae and stomach. Breath sounds should be similar on each side and not be heard over stomach. May be difficult to assess in very immature infants. In special circumstances (e.g. pneumothorax, diaphragmatic hernia) there may be asymmetrical breath sounds
  - if breath sounds unequal and louder on right, withdraw ETT by 0.5 cm and listen again
- If ETT tip in the trachea, and using a clear ETT, mist may condense on inside of tube during expiration
  - stabilise tube using ETT fixation method in accordance with unit practice
  - reduce dead space by cutting ETT to shorten it
  - request chest X-ray: adjust ETT length so tip is at level of T1–2 vertebrae and document on nursing chart and in baby's hospital notes

Intubation failure

Definition: Unable to intubate within 30 sec

- If intubation unsuccessful, seek help from someone more experienced
- If risk of aspiration, maintain cricoid pressure
- Continue mask ventilation until successful intubation achieved

- **Limit hypoxia by:**
- limiting the intubation attempt to prevent excess fall in oxygen saturation and/or heart rate – supportive team member to be available to determine when attempt should cease and reoxygenation be implemented
- providing appropriate ventilation before and between intubation attempts

Record keeping

- Indication for intubation
- Mention oral endotracheal intubation as the procedure undertaken
- ETT size and position at cords and lips
- Radiological position of tip of ETT and any adjustments following X-ray
- Medication chart completed
- Baby's tolerance of procedure and any adverse events

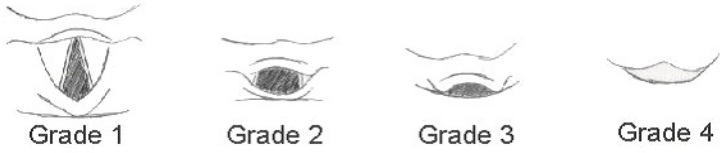
COMMUNICATION

- Inform parents of procedure and events

INTUBATION – DIFFICULT ● 1/4

BACKGROUND

In most babies, direct laryngoscopy results in a clear view of the larynx. The laryngeal view is classified by Cormack and Lehane as follows:



Grade 1	Visualisation of entire laryngeal aperture There should be no difficulty in intubation
Grade 2	Visualisation of just the posterior portion of laryngeal aperture May be slight difficulty Cricoid pressure should improve visualisation
Grade 3	Visualisation of only the epiglottis Can result in severe difficulty; cricoid pressure may be helpful
Grade 4	Visualisation of soft palate only, not even the epiglottis is visible Always difficult and usually accompanies obvious pathology but may also occur totally unexpectedly. Senior support may be required

A 'difficult airway' is a situation in which a trained practitioner has difficulty with face mask ventilation and/or tracheal intubation

A difficult airway with failed intubation should be declared after 2 unsuccessful intubation attempts by an experienced practitioner or if they judge the airway to be difficult

MANAGEMENT PLAN

- Use premedication as appropriate for your unit
- Good practice to have team around the baby familiar with each other's names, and assigned roles for the intubation (e.g. team leader with oversight, medication, equipment)
- Difficult neonatal intubation may occur at or after delivery and may be:
- anticipated (e.g. Pierre Robin sequence, Treacher–Collins, cleft lip and palate, Goldenhar syndrome, Apert/Crouzon syndrome, Down syndrome) **or**
- unanticipated (e.g. subglottic stenosis, laryngeal atresia, laryngeal or tracheal webs, glottic oedema post extubation)
- Where difficult intubation anticipated, ensure senior help is available before commencing (senior experienced tier 2 staff, consultant or, if indicated, ENT consultant/anaesthetist)
- If difficult airway anticipated, use video laryngoscope

Difficult airway pack

- Infant oropharyngeal airways (Guedel, sizes 000, 00, 0)
- ETT size 2–4.5 with stylet for intubation
- ETT size 2–4.5 with scissors, to cut short for use as nasopharyngeal airway support
- ETT fixation equipment
- Straight bladed laryngoscopes for big and small baby
- Forceps
- Supraglottic airway devices, e.g. laryngeal mask airways (LMAs) with inflatable cuff size 1 for babies >2 kg or i-gel with non-inflatable cuff size 1 for babies 1.5–5 kg
- Size 2.5–4.5 endotracheal bougies for railroading ETT
- Video laryngoscope and blades
- CO_2 detector e.g. Pedicap®

Can ventilate, cannot intubate
(Good chest excursion and rising/good heart rate but baby still needs intubation)

- No more than 4 attempts at intubation (2 per individual resuscitator), to avoid laryngeal oedema and avoid converting this into a 'cannot intubate, cannot ventilate' scenario
- ventilate between attempts with 100% oxygen
- maximum 30 sec per attempt to limit hypoxia

- Call for senior help
- If intubation attempts fail, stop. Continue either bag and mask ventilation or LMA ventilation until senior help available
- it is safer to maintain ventilation with mask ventilation with adequate chest expansion until help arrives, as baby is less likely to tolerate repeated unsuccessful ETT attempts
- 2 further attempts by senior resident doctor/neonatologist
- Try indirect laryngoscopy using video laryngoscope. If this fails, call for ENT support for rigid bronchoscopy or surgical tracheostomy, or ENT/anaesthetist for flexible fibrescope assisted intubation depending on your hospital's availability
- Use end tidal CO_2 detectors (e.g. Pedicap®) to confirm tracheal intubation

Cannot ventilate, cannot intubate

- Call for senior help
- Reconfirm the following:
- neutral head position (overextension can limit vision)
- correct size face mask being used, create a tight seal
- use correct size oropharyngeal airway (Guedel airway): too big may cause laryngospasm and too small may worsen obstruction. (Tip of Guedel airway should reach angle of jaw when aligned with lip on side of face)
- use 2 person jaw-thrust
- ensure pressures for mask ventilation are adequate
- cold light to exclude pneumothorax
- For specific conditions (e.g. Pierre Robin sequence, micrognathia) nasopharyngeal airway may be useful. To make, take an ETT and shorten it by measuring distance between nasal tip and ear tragus. Choose a size that does not blanch the nares completely when inserted
- Ventilation with supraglottic airway devices (LMA with inflatable cuff size 1 for babies ≥2 kg or i-gel with non-inflatable cuff size 1 for babies 1.5–5 kg)
- Start nasal cannula or high flow oxygen at 100%
- When senior help arrives:
- reattempt intubation
- use a small towel roll under baby's shoulder to improve vision
- use indirect laryngoscopy with video laryngoscope
- Call ENT or anaesthetist for support (ENT for rigid bronchoscopy or surgical tracheostomy, or anaesthetist for flexible fibrescope assisted intubation as above**,** depending on your hospital's availability)
- Use end tidal CO_2 detector (e.g. Pedicap®) to confirm tracheal intubation

Prevent/anticipate difficult intubation/reintubation

- For ventilated babies due for extubation, risk of difficult reintubation can be reduced by pre-extubation dexamethasone to reduce cord oedema, especially in babies who had difficult initial intubations or chronic ventilatory course
- if ETT leak <10–15%, consider dexamethasone

Common problems with intubation

Problem	Action
Oesophageal intubation – blade placed too deep, cords not visualised	• Retry with shallow blade insertion and use cricoid pressure
Tongue obscures vision	• Sweep tongue to left side using blade • Use a more anterior lift • Use straight blade (Miller)
Cannot see cords	• Ensure head not hyper-extended • Use small towel roll under baby's shoulders
Cannot intubate	• Do not panic • Calmly maintain chest excursions through bag or T-piece/face or laryngeal mask ventilation until help arrives • Use Guedel oral airway if necessary • Call for senior help

Seek senior support in the following situations:
- **Blind intubation:** in small baby where poor visualisation due to size
- **Supraglottic airway devices (LMA size 1 or i-gel size 1):** can be inserted by juniors while awaiting senior support if trained (see below for details)
- **Video laryngoscope:** to guide intubation through the cords
- **Railroad technique:** if laryngeal aperture narrow, insertion of bougie through cords, and railroading ETT over it
  - usually a 2-person procedure and can be carried out under direct vision/blind, depending on visual field and equipment
  - carefully insert a bougie through vocal cords, ≤2 cm beyond aperture opening
  - keep bougie steady while colleague threads ETT over top end of stylet and into trachea. **Note:** using a stylet from the ETT pack carries risk of oesophageal/tracheal perforation
- **Ultra-small fibre-optic bronchoscopy** (if available locally): with railroading via bronchoscope
- **Surgical tracheostomy**: not undertaken by neonatal consultants – seek ENT support
- **Note: Prolonged procedure** – additional dose of muscle relaxant can be used under senior guidance
  - ensure venous access obtained
  - support cardiac system with IV fluid boluses as required
  - use inotropic agents as required, based on perfusion and blood pressure (see **Hypotension** guideline)
- Keep baby warm using techniques supported by your local unit e.g. TransWarmer®, bubble wrap
- Empty stomach contents regularly while on face mask/T-piece ventilation

i-gel

- Supraglottic mask with soft non-inflatable cuff attached to an airway tube
- Once inserted, anterior tip enters upper oesophagus while cuff conforms to contours of perilaryngeal structures, with lumen facing laryngeal opening
- Once successfully inserted can be connected to a positive pressure inflation device i.e. ambu bag/Neopuff™
- Size 1 suitable for babies >1.5 kg, usually ≥32 weeks' gestation
- ETT can be passed (size 3) through central port within i-gel (size 1)

Indications
- Babies >1.5 kg, ≥32 weeks' gestation when:
  - bag and mask ventilation ineffective/problematic and endotracheal intubation unsuccessful
  - bag and mask and endotracheal intubation not immediately feasible due to facial and/or airway deformities
  - may be beneficial as a more stable airway during transport of sick neonate (needing positive pressure ventilation by mask) by paramedics/midwifery staff from home or midwifery-led unit to NNU

i-gel should not be used:
- In the setting of meconium-stained amniotic fluid
- When chest compressions required
- For delivery of drugs into the trachea

Advantages
- Ease of insertion
- Minimal risk of tissue compression and instability after insertion
- Easily learned skill and easily replicated
- Less invasive than endotracheal intubation
- Insertion does not require neuromuscular blockers and sedation

Insertion technique
- Place head centrally in 'air-sniffing' position
- Remove i-gel from sterile protective cage
- Grasp i-gel close to the connector; lubricate back, sides and front of cuff with a thin layer of lubricating gel, ensuring no lubricant remains in the bowl of the cuff (oral secretions alone may be sufficient to aid movement)
- Depress baby's chin, thereby enlarging oral cavity
- Grasp i-gel close to cuff, holding it like a pen
- Point i-gel tip cranially against hard palate

- Glide device downwards and backwards along the hard palate with a continuous but gentle push until definitive resistance felt
- I-gel will advance along the posterior pharyngeal wall, with tip locating itself in the upper oesophagus
- Attach to Neopuff™/bag and mask ventilation at pre-set pressures
- Observe for signs of clinical improvement, confirmed by chest movement, increasing heart rate, improving colour and saturations
- Listen for air leaks (may not be in correct position)
- Ensure device remains centrally placed (black i-gel logo visible in central position)
- Once position confirmed and clinically effective, tape from maxilla to maxilla to avoid loss of airway

Following i-gel insertion

- **Do not** allow peak pressure of ventilation to exceed 40 cm H_2O
- **Do not** use excessive force to insert device
- Excessive air leak during manual ventilation is due to suboptimal depth of i-gel insertion, malposition or excessive peak pressure use
- Do not leave device *in situ* for >4 hr without senior advice
- Do not reuse the i-gel
- No more than 3 attempts should be attempted in one patient

Complications/side effects

- Malposition
- Vagal response
- Gastric ventilation, distension and aspiration
- Laryngospasm or trauma to the pharyngolaryngeal framework

COMMUNICATION

- Inform parents of procedure and events

FURTHER INFORMATION

- See BAPM framework algorithm for step-by-step approach of managing difficult airway https://hubble-live-assets.s3.eu-west-1.amazonaws.com/bapm/file_asset/file/79/DA_framework_final_October_2020.docx.pdf

JAUNDICE ● 1/3

Based on **NICE CG98 Jaundice in newborn babies under 28 days**

RECOGNITION AND ASSESSMENT

Risk factors for hyperbilirubinaemia

- <38 weeks' gestation
- Previous sibling required treatment for jaundice
- Mother intends to breastfeed exclusively
- Visible jaundice in baby aged <24 hr

Risk factors for kernicterus

- High bilirubin level (>340 micromol/L in term baby)
- Rapidly rising bilirubin level (>8.5 micromol/L/hr)
- Clinical features of bilirubin encephalopathy

Signs

- When looking for jaundice (visual inspection):
  - check naked baby in bright and preferably natural light
  - examine the sclerae and gums, and press lightly on skin to check for signs of jaundice in 'blanched' skin
  - may be harder to see in darker skin

Assess

- Pallor (haemolysis)
- Poor feeding, drowsiness (neurotoxicity)
- Hepatosplenomegaly (blood group incompatibility or cytomegalovirus)
- Splenomegaly (spherocytosis)

Causes

- Physiological
- Prematurity
- Increased bilirubin load:
  - blood group incompatibility (Rhesus or ABO)
  - G6PD deficiency and other red cell enzyme deficiencies
  - congenital spherocytosis
  - cephalhaematoma, bruising
- Rarely infection (e.g. UTI, congenital infection)
- Metabolic disorder

Persistent jaundice after aged 14 days (see *Liver dysfunction* guideline)

- Breast milk jaundice
- Hypothyroidism
- Liver disease (e.g. extra hepatic biliary atresia and neonatal hepatitis)
- Alpha-1-antitrypsin deficiency
- Galactosaemia
- TPN-induced cholestasis

Investigations

Assessment of jaundice

- Babies aged <72 hr, at every opportunity (risk factors and visual inspection)
  - do not routinely measure bilirubin in babies not visibly jaundiced
- Babies with suspected or obvious jaundice, measure and record bilirubin level urgently
  - <24 hr: within 2 hr
  - ≥24 hr: within 6 hr
- If serum bilirubin >100 micromol/L in first 24 hr
  - measure 6-hrly until level is both below treatment threshold and stable/falling
  - interpret result in accordance with baby's age and gestation see **threshold graph** (http://www.nice.org.uk/guidance/CG98 under 'Tools and resources' then 'CG98 Neonatal Jaundice: treatment threshold graphs')
  - urgent medical review as soon as possible (and within 6 hr, or 2 hr if baby aged <24 hr)
- Interpret bilirubin result in accordance with baby's gestational and postnatal age according to threshold graph

Use of transcutaneous bilirubinometer

- May be used for initial bilirubin measurement for babies aged >24 hr **and** gestation ≥35 weeks
- If reading >250 micromol/L check serum bilirubin
- If serum bilirubin ≥ treatment threshold, use serum bilirubin for all subsequent measurements

Jaundice approaching treatment level

- If baby well, ≥38 weeks, aged >24 hr **and**
- serum bilirubin ≤50 micromol/L below treatment threshold, repeat measurement in 18 hr if risk factors and 24 hr if no risk factors
- serum bilirubin >50 micromol/L below treatment threshold, no further routine measurements required

Jaundice requiring treatment

- Total bilirubin
- Baby's blood group and direct Coombs test (interpret result taking into account strength of reaction and whether mother received prophylactic anti-D immunoglobulin during pregnancy)
- Mother's blood group and antibody status (should be available from maternal healthcare record)
- PCV

Plus (if clinically indicated)

- Full infection screen (in an ill baby) or jaundiced within 24 hr of birth
- G6PD level and activity (if indicated by ethnic origin: Mediterranean, Middle Eastern, South East Asian)
- FBC and film

***Persistent jaundice >14 days term baby; >21 days preterm baby* (see Liver dysfunction *guideline*)**

- Total and conjugated bilirubin
- Examine stool colour
- FBC
- Baby's blood group and direct Coombs test (interpret result taking into account strength of reaction and whether mother received prophylactic anti-D immunoglobulin during pregnancy) [see **Blood group incompatibilities (including Rhesus disease)** guideline]
- Ensure routine metabolic screening performed (including screening for hypothyroidism)
- If clinical suspicion of UTI, discuss urine culture with consultant

Baby with conjugated bilirubin >25 micromol/L, refer urgently to a specialist centre

Second line investigations (not in NICE guideline)

- Liver function tests (ALT, AST, albumin, GGT)
- Coagulation profile
- G6PD screen if African, Asian or Mediterranean
- Thyroid function tests: ask for 'FT4 priority and then TSH'
- Congenital infection screen
- Urine for CMV PCR, toxoplasma ISAGA-IgM and throat swab for HSV culture/PCR
- Metabolic investigations e.g:
- blood galactose-1-phosphate
- urine for culture and reducing substances
- alpha-1-antitrypsin

TREATMENT <7 DAYS

Do not start treatment if serum bilirubin is below treatment threshold

Babies ≥38 weeks' gestation

- Use conventional blue light phototherapy (not fibre optic) as treatment of choice
- Use continuous multiple phototherapy for babies who:
- fail to respond to conventional phototherapy (bilirubin does not fall within 6 hr of starting treatment)
- have a rapid rise in bilirubin (>8.5 micromol/L/hr)
- have a bilirubin level within 50 micromol/L of exchange transfusion threshold at 72 hr

- when level falls to >50 micromol/L below exchange transfusion threshold reduce intensity of phototherapy
- If exchange transfusion threshold crossed see **Exchange transfusion** guideline

Babies <38 weeks' gestation

- Use fibre optic or conventional blue light as first line treatment
- based on gestational age and postnatal age, use **Threshold graphs** (http://www.nice.org.uk/guidance/CG98 under 'Tools and resources' then 'CG98 Neonatal Jaundice: treatment threshold graphs') to determine threshold for phototherapy
- use gestational age at birth, not corrected gestational age
- Indications for multiple phototherapy as term babies

Management during phototherapy

- Offer parents information on procedure (www.nice.org.uk/guidance/cg98/resources/jaundice-in-newborn-babies-318006690757)
- Unless other clinical conditions prevent, place baby in supine position
- Ensure treatment applied to maximum area of skin
- Monitor baby's temperature
- Monitor hydration by weighing baby daily and assessing wet nappies
- Use eye protection and give routine eye care
- Provided bilirubin not significantly elevated, encourage breaks of up to 30 min for breastfeeding, nappy change and cuddles
- Do not give additional fluids routinely
- During multiple phototherapy:
- do not interrupt for feeds
- continue lactation/feeding support so that breastfeeding can recommence when treatment stops

Monitoring during phototherapy

- Repeat serum bilirubin 4–6 hr after starting treatment
- Repeat serum bilirubin 6–12 hrly when bilirubin stable or falling
- Stop phototherapy once serum bilirubin has fallen to at least 50 micromol/L below threshold
- Check for rebound jaundice with repeat serum bilirubin 12–18 hr after stopping phototherapy. Babies do not necessarily need to remain in hospital for this to be done

DISCHARGE AND FOLLOW-UP

- GP follow-up with routine examination at 6–8 weeks
- If exchange transfusion necessary or considered, request developmental follow-up.
- In babies with positive direct Coombs test who required phototherapy arrange haemoglobin check at 2 weeks.
- further follow-up and haemoglobin checks may be needed according to clinical history and results [see **Blood group incompatibilities (including Rhesus disease)** guideline]
- give folic acid 1 mg daily. Stop when haemoglobin stable and discharge from follow-up
- Treatment graphs giving the phototherapy and exchange transfusion limits for each gestational age can be printed from http://www.nice.org.uk/guidance/CG98 under 'Tools and resources' then 'CG98 Neonatal Jaundice: treatment threshold graphs'

KANGAROO CARE● 1/2

DEFINITION

- Method of holding preterm and/or sick baby skin-to-skin in an upright position between mother's breasts or against carer's chest
- can also be carried out by fathers/partners, siblings, surrogate families and foster carers
- Kangaroo care (KC) can be offered to parents of medically stable babies

Benefits of KC

- Inform parents about the benefits of KC (use 'BLISS Skin-to-skin and Kangaroo Care' information https://www.bliss.org.uk/parents/in-hospital/looking-after-your-baby-on-the-neonatal-unit/skin-to-skin-and-kangaroo-care or locally approved information leaflets):
- helps promote physiological stability: regulates baby's temperature, heart rate, breathing and oxygen saturation
- reduces incidence of apnoea and bradycardia
- increases time in quiet sleep
- longer alert states and less crying
- analgesic effect during painful procedures
- promotes growth and earlier discharge
- improves lactation and breastfeeding success – duration and exclusivity
- promotes parent–baby attachment and family-centred care
- positive effect on parenting – reduces stress and depression, triggers healing process, increases confidence
- helps reduce risk of mortality among preterm and low-birth-weight babies

INDICATIONS

- Medically stable baby – including those on CPAP with a stable oxygen requirement
- Medically stable ventilated babies after discussion with MDT
- Ventilated babies receiving palliative care

If concerns regarding stability of baby, discuss with senior member of medical and nursing team

CONTRAINDICATIONS

- Umbilical lines *in situ*/unstable baby – recommend alternative methods of touching/comfort holding to parents

Consider

- Baby's condition and dependency
- Maintenance of neutral thermal environment and humidity
- Activity in the room – quiet, calm environment is preferable
- Support available from colleagues

Ensure

- Access to oxygen and suction

PARENT PREPARATION

- Discuss benefits of kangaroo care for both parents and baby at any available opportunity
- Ensure parents are aware that baby may be briefly unstable during transfer from/to incubator/cot
- Suggest parents do not smoke immediately before KC time
- Choose a mutually convenient time for parents and baby
- Provide privacy for parents to prepare clothing – suggest parents wear a clean loose fitting, front fastening shirts
- Provide comfortable chair and foot rest if appropriate
- Offer a hand-held mirror – to enable parent to see baby's face
- Advise parents to bring a drink and go to toilet before KC time

Nurse transfer

Recommended initial transfer method. Use this method until parents feel confident

- Parent to sit slightly reclined in a comfortable chair. Ensure clothing open and ready to receive baby

- Contain baby's limbs and move gently – use 'snuggle up' nest if appropriate
- Place baby on parent's chest, prone with head to parent's sternum
- Parent to support baby's head and body with baby's legs flexed
- Turn baby's head to side to protect airway
- Use parent's clothing and a wrap/blanket for warmth and support
- If appropriate, place hat on baby

Parent transfer

- Parent to stand at side of incubator
- Place forearm gently under 'snuggle up' nest or sheet, cup baby's head with other hand
- Gently lift baby from incubator and onto chest, resting baby's head against sternum while supporting baby's back and bottom with forearm
- Parent gently moves back to sit in chair, guided by nurse
- Nurse to check baby's position as before

Duration of KC

- When baby settled, remove screens/curtains – be guided by parental preference
- Aim to provide KC for ≥1 hr
- Monitor baby's position and vital signs
- Babies may have nasogastric tube feeds during KC time
- Discontinue KC if:
- baby shows signs of distress
- has a prolonged increase in oxygen requirement of 10–20%
- at parent's request

Breast milk

- Encourage mother to express breast milk following KC time. See **Breast milk expression** guideline

KAISER PERMANENTE SEPSIS RISK CALCULATOR ● 1/5

Based on https://neonatalsepsiscalculator.kaiserpermanente.org

This Guideline should be used in conjunction with:
Infection in the first 72 hours of life *guideline and* NICE NG195 Neonatal infection: antibiotics for prevention and treatment *updated April 2021*

INTRODUCTION

The Kaiser Permanente Sepsis Risk Calculator (KP-SRC) is an online calculator used to determine which well babies meeting the NICE criteria for treatment for possible early onset neonatal infection should receive antibiotics

Inclusion criteria

- Babies who meet the criteria for antibiotic treatment as defined by NICE (See **Infection in the first 72 hours of life** guideline) **and**:
- ≥34 weeks' gestation **and**
- aged ≤12 hr **and**
- clinically well

Exclusions

- Follow **Infection in the first 72 hours of life** guideline if:
- antibiotics not recommended by NICE **or**
- baby clinically unwell **or**
- baby <34 weeks' gestation **or**
- baby aged >12 hr **or**
- confirmed Group B streptococcal (GBS) sepsis or neonatal death in a previous pregnancy and mother has not receive adequate intrapartum prophylaxis (see **Group B streptococcal colonisation of mother** guideline) **or**
- co-twin meets criteria for antibiotics

KPSRC is a risk calculator and has limitations in identifying all babies with sepsis. If any clinical concerns, even with a low calculation risk, discuss with neonatal tier 2 staff or consultant at earliest opportunity
If baby clinically unwell, treat with antibiotics within 1 hr and follow* Infection in the first 72 hours of life *guideline

APPLICATION OF THE KP-SRC

If KP-SRC not available follow* Infection in the first 72 hours of life *guideline

Identification of babies (see Flowchart: Application of KP-SRC for a baby who meets the criteria for antibiotics)

- If baby meets NICE criteria for antibiotics midwife/nursery nurse to alert neonatal team immediately
- Neonatal team to assess baby's eligibility for KPSRC and if eligible determine baby's status as well/equivocal/clinical illness using **Table 1**

KAISER PERMANENTE SEPSIS RISK CALCULATOR ● 2/5

Table 1

Clinical examination	Description
Well appearing	• No persistent physiological abnormalities
Equivocal	**Any one of the following persisting ≥4 hr after birth*** • Tachycardia (HR ≥160 bpm) • Tachypnoea (RR ≥60) • Temperature <36.5°C or ≥38°C • Respiratory distress (grunting, nasal flaring or chest recessions) not requiring supplemental oxygen **≥2 of the following lasting ≥2 hr†** • Tachycardia (HR ≥ 160 bpm) • Tachypnoea (RR ≥ 60) • Temperature <36.5°C or ≥38°C • Respiratory distress (grunting, nasal flaring or chest recessions) not requiring supplemental oxygen * Abnormalities can be intermittent † If any observations abnormal for 2 consecutive hours – arrange middle grade review and consider commencing antibiotics
Clinical Illness	• Persistent need for CPAP/HFNC/mechanical ventilation (outside of the delivery room) • Haemodynamic instability requiring fluid bolus or inotropes • Neonatal encephalopathy/perinatal depression ◦ seizure ◦ Apgar score <5 at 5 min • Need for supplemental oxygen ≥2 hr to maintain SpO_2 >90% • Any other symptoms of serious illness – clinician determined • Following should also be classified as clinical illness ◦ equivocal state persisting >2 hr ◦ onset of symptoms at >4 hr after an asymptomatic period

Application of sepsis risk score

- Access the sepsis risk calculator via maternity **BadgerNet** – early onset sepsis calculator or via web https://neonatalsepsiscalculator.kaiserpermanente.org
- Enter **2/1000** live births as incidence of early-onset sepsis (EOS)
- Calculate sepsis risk score to determine individual baby's risk for EOS and follow recommendations for management based on KP-SRC
- Note the following West Midlands modification of KP-SRC:
  - if KP-SRC recommends blood culture: treat baby with antibiotics until culture results available and follow **Infection in the first 72 hours of life** guideline
  - if KP-SRC recommends observations for 24 hr: observe baby for ≥36 hr
- SRC can be re-applied based on baby's clinical status at any time up to aged 12 hr
- **Variables input onto KP-SRC calculator to be cross-checked by both neonatal team and midwife (caring for mum and baby) to ensure no errors**
- Clearly document recommended plan regarding observations or antibiotics on **BadgerNet** (under baby's clinical note) or in baby's paper notes
  - ensure plan handed over to midwife
- If KP-SRC accessed via web:
  - print copy of EOS risk score calculated by KP-SRC
  - attach patient label to print out
  - medic (who calculated) and midwife (who cross-checked) to sign and date
  - file in baby's notes or scan/upload screenshot to the maternity EPR
  - not required if KP-SRC accessed via **BadgerNet**. Further guidance given in **Table 2**

Table 2

Calculator input	Value to be entered	Notes
Incidence of early-onset sepsis	2/1000 live births	Based on local incidence
Gestational age (GA)	GA in weeks and days	Weeks range: 34–43 Days range: 0–6
Highest maternal intrapartum temperature (˚C)	Units ˚Celsius Use highest intrapartum maternal temperature including up to 1 hr following delivery	Use whole number or number with single decimal place e.g.: 37, 37.1, 37.0 **NOTE: If postpartum temperature within 1 hr of birth is ≥0.5˚C above intrapartum temperature, midwives to document and inform neonatal team**
ROM (hours)	Use entire duration of rupture of membranes to delivery, not just pre-labour duration	Round value to single decimal place, e.g. enter ROM 4 hr 30 min as 4.5 hr, 4 hr 55 min as 5.0 hr
GBS	Enter maternal GBS screening result in current pregnancy if available. If not known enter 'unknown'	
Type of Intrapartum Antibiotics **and** **Interval from first dose to birth**	• **'GBS-specific antibiotics'** are defined **ONLY** as benzylpenicillin G. ampicillin is an acceptable alternative. Penicillin-allergic women with no history of anaphylaxis, angioedema, respiratory distress, or urticaria after administration of penicillin or a cephalosporin should receive cefuroxime ◦ should apply only to mothers who are GBS positive or GBS unknown • If erythromycin, clindamycin or vancomycin **ALONE** are given for GBS prophylaxis, choose the option **'No antibiotics or any antibiotics given <2 hr prior to delivery'** • ***'Broad-spectrum antibiotics (BSAB)'*** defined as ≥2 antibiotics given in combination when concern for the mother developing chorioamnionitis • ***'Timing'*** of administration of '**GBS-specific antibiotics'** or '**BSAB administration'** = interval between first dose of benzylpenicillin G or second antibiotic in the combination to the time of birth ◦ e.g.: cefuroxime at 2:00 pm, metronidazole at 3:30 pm, birth at 4:30 pm, so 2nd antibiotic given 1 hr before delivery. Choose '**No antibiotics or any antibiotics given <2 hours prior to delivery'** • If mother given **BOTH** GBS-specific antibiotics and BSAB – of the 4 possible options, select the category with the longest duration of treatment ◦ e.g.: benzylpenicillin G at 8:00 pm and 12:00 pm for GBS positive, then develops fever to 38.3°C at 2:00 pm so cefuroxime given at 3:00 pm. Benzylpenicillin G given at 4:00 pm, birth at 4:30 pm. GBS-specific antibiotics were given >4 hr before delivery, but BSAB were given only 1.5 hr before delivery. Choose '**GBS specific antibiotics given >2 hours prior to birth'**	

OBSERVATIONS:

All babies on whom KP-SRC has been applied should have regular observations as shown in table below

Table 3

Clinical status	Observation schedule
Well appearing	• Routine observations at aged1 hr and aged 2 hr, **then** • 2-hrly until aged 12 hr, **then** • 4-hrly until aged 36 hr (despite KP-SRC recommending only 24 hr in some)
Equivocal	• Hourly until all observations in normal range for 2 consecutive measurements. Then follow guidance for well appearing baby • If any 2 consecutive measurements abnormal or equivocal request middle grade assessment and review need for antibiotics
Unwell	• Admit to NICU and observation as directed by clinician

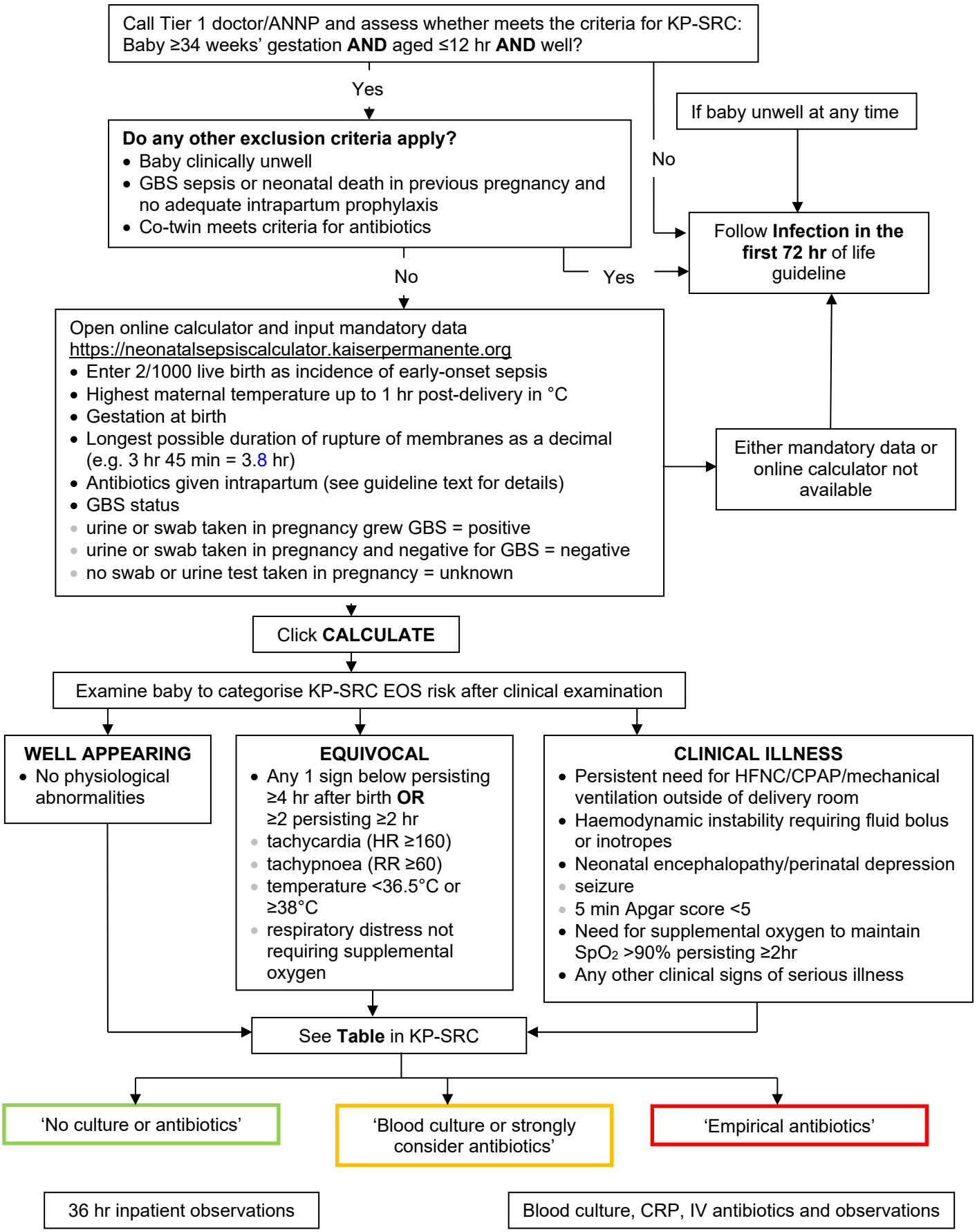
SUBSEQUENT MANAGEMENT

- If baby appears unwell at any time or in equivocal state for >2 hr, treat baby with antibiotics following **Infection in first 72 hours of life** guideline
- Give parents **Screening for infection in newborn babies – information for parents** leaflet

DISCHARGE

- All babies on KP-SRC observation pathway to be observed for ≥36 hr in hospital and re-examined by neonatal team before discharge to confirm well-being

APPLICATION OF KP-SRC FOR A BABY WHO MEETS THE CRITERIA FOR ANTIBIOTICS


Call Tier 1 doctor/ANNP and assess whether meets the criteria for KP-SRC: Baby ≥34 weeks' gestation AND aged ≤12 hr AND well?
Yes
No
If baby unwell at any time
Do any other exclusion criteria apply?
• Baby clinically unwell
• GBS sepsis or neonatal death in previous pregnancy and no adequate intrapartum prophylaxis
• Co-twin meets criteria for antibiotics
No
Yes
Follow Infection in the first 72 hr of life guideline
Open online calculator and input mandatory data
https://neonatalsepsiscalculator.kaiserpermanente.org
• Enter 2/1000 live birth as incidence of early-onset sepsis
• Highest maternal temperature up to 1 hr post-delivery in °C
• Gestation at birth
• Longest possible duration of rupture of membranes as a decimal (e.g. 3 hr 45 min = 3.8 hr)
• Antibiotics given intrapartum (see guideline text for details)
• GBS status
◦ urine or swab taken in pregnancy grew GBS = positive
◦ urine or swab taken in pregnancy and negative for GBS = negative
◦ no swab or urine test taken in pregnancy = unknown
Either mandatory data or online calculator not available
Click CALCULATE
Examine baby to categorise KP-SRC EOS risk after clinical examination
WELL APPEARING
• No physiological abnormalities
EQUIVOCAL
• Any 1 sign below persisting ≥4 hr after birth OR ≥2 persisting ≥2 hr
◦ tachycardia (HR ≥160)
◦ tachypnoea (RR ≥60)
◦ temperature <36.5°C or ≥38°C
◦ respiratory distress not requiring supplemental oxygen
CLINICAL ILLNESS
• Persistent need for HFNC/CPAP/mechanical ventilation outside of delivery room
• Haemodynamic instability requiring fluid bolus or inotropes
• Neonatal encephalopathy/perinatal depression
◦ seizure
◦ 5 min Apgar score <5
• Need for supplemental oxygen to maintain SpO2 >90% persisting ≥2hr
• Any other clinical signs of serious illness
See Table in KP-SRC
'No culture or antibiotics'
'Blood culture or strongly consider antibiotics'
'Empirical antibiotics'
36 hr inpatient observations
Blood culture, CRP, IV antibiotics and observations

Refer to text of guideline for details of observations

- Encourage obstetric team to warn neonatal team of expected problems **well in advance**
- Decide who should attend (e.g. first on-call, tier 2 staff or consultant), and degree of urgency

Neonatal team should attend the following deliveries:

- Non-reassuring electronic fetal monitoring trace, as assessed by obstetric team
- Significant fresh meconium in liquor
- Major congenital abnormalities (minor abnormalities will wait until working hours)
- Vacuum extraction or instrumental deliveries performed for fetal reasons (see below)
- Preterm delivery <36 weeks' gestation
- Severe pre-eclampsia with seizures
- Antepartum haemorrhage
- Moderate-to-severe Rhesus disease
- Unexpected breech delivery
- Any delivery under general anaesthesia

It is **not** necessary for neonatal team to attend the following deliveries:

- Elective caesarean section under regional anaesthesia
- Meconium staining of liquor
- Planned breech delivery (including caesarean section under regional anaesthesia)
- Twins (>36 weeks)
- Pre-eclampsia without seizures

The following factors may require neonatal team to attend birth or assess baby soon after birth (see antenatal plan in maternal notes)

- Maternal illness likely to affect baby:
  - diabetes mellitus
  - thyroid disease
  - systemic lupus erythematosus
  - myasthenia gravis
  - myotonic dystrophy
  - hepatitis B carriage
  - intrapartum antibiotics indicated but not given, or given <4 hr before delivery
  - HIV
  - HELLP syndrome
  - suspected sepsis treated with IV antibiotics
- Maternal medications that may affect baby e.g. antidepressants
- Maternal substance abuse
- Neonatal alerts:
  - abnormal antenatal scans
  - low-birth-weight baby <2.5 kg
- Pregnancy and past history
  - prolonged rupture of membranes
  - polyhydramnios
  - previous baby/perinatal death
  - family history of genetic or metabolic abnormalities

LIVER DYSFUNCTION IN PRETERM BABIES ● 1/3

DEFINITION

- Cholestasis: conjugated bilirubin ≥25 micromol/L and/or ≥25% of total bilirubin
- Acute liver failure with raised transaminase and coagulopathy unresponsive to vitamin K

Discuss all babies with liver dysfunction at term urgently with liver unit team

CAUSES

- Not all liver dysfunction in preterm babies is caused by parenteral nutrition. Extra-hepatic biliary atresia does occur and must be diagnosed and managed in a timely fashion

Biliary tract disorders	Neonatal hepatitis	Metabolic
• Extra-hepatic biliary atresia • Bile duct stricture • Choledochal cyst • Alagille syndrome • Non-syndromic bile duct paucity	**Isolated** • Associated with: ◦ parenteral nutrition ◦ maternal diabetes ◦ hydrops fetalis ◦ genetic disorders – trisomies, Turners syndrome	• alpha-1 antitrypsin deficiency • Cystic fibrosis • Galactosaemia • Bile acid disorder • Neonatal haemochromatosis • Hereditary tyrosinaemia • Nieman-pick disease • Mitochondrial disorders • Several others
Infection	**Endocrine**	**Toxins/injury**
• Cytomegalovirus • Toxoplasmosis • Sepsis • Hepatitis • Enterovirus • Herpes simplex virus • Parvovirus	• Hypopituitarism • Hypothyroidism	• Parenteral nutrition • Multifactorial preterm • Haemolytic disease • Hypoxia • Fetal alcohol syndrome • Shock/venous thrombosis • Drugs

SIGNS

- Pale or acholic stools
- Dark urine
- Prolonged jaundice (defined as visible jaundice at day 14 in term and day 21 in preterm babies)
- Bleeding, including intraventricular haemorrhage from vitamin K deficiency
- Green jaundice on any day of life
- Acute collapse with liver failure
- Hypoglycaemia

INVESTIGATIONS

Aim to diagnose causes of liver dysfunction that will benefit from early diagnosis while avoiding unnecessary transfer and investigation of small sick babies

First line investigations

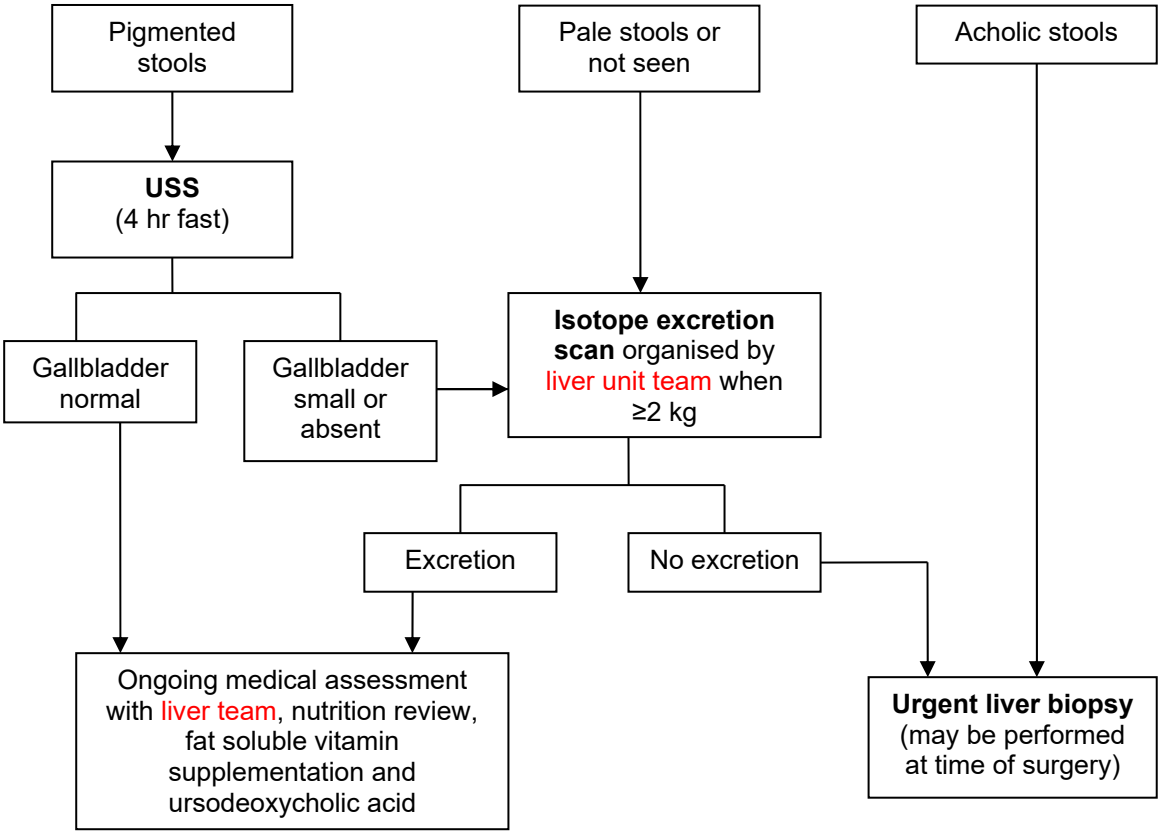
- Complete the following as soon as possible:
- FBC and film
- coagulation screen
- blood gas – glucose and lactate
- transaminases, including ALT, AST, bilirubin (total and conjugated), albumin, gamma GT, and alkaline phosphatase, LDH, AFP, ferritin
- albumin
- galactosaemia and tyrosinaemia screen
- alpha-1 antitrypsin concentration **and** phenotype
- serum cortisol, T4 and TSH
- stool in opaque pot for consultant review
- urine for MC&S
- abdominal ultrasound scan, after 4 hr fast if possible, to include liver and gallbladder examination

- if high clinical suspicion, toxoplasma serology, hepatitis E serology, CMV IgM or urine PCR for CMV, syphilis serology, viral culture from swabs of any vesicles for herpes simplex
- if metabolic disorder suspected, plasma lactate, plasma and urine amino acids, urine organic acids, ammonia
- discuss with biochemistry before sampling (transport may need to be arranged)

As they become available, discuss results of liver function, coagulation, stool colour, weight gain and abdominal ultrasound with liver unit team

FURTHER INVESTIGATIONS

- Follow advice of liver team
- Standard aggressive protocol used to investigate term babies is inappropriate in preterm babies due to:
- insufficient blood volume for blanket testing
- poor temperature control when attending for isotope scans
- limited size increases risk of liver biopsy
- Transfer to specialist centre often not possible owing to need for ongoing respiratory support and neonatal nursing care
- Preterm babies with diagnoses requiring surgery (e.g. Kasai procedure for biliary atresia) need to be around 2 kg before surgery performed but liver team should be informed in advance of baby reaching this weight
- Early isotope scanning not widely available and of limited value, many babies can be investigated without this procedure – follow advice of liver team
- Assessment of stool colour can determine which babies with cholestasis require urgent further investigation, as shown below:


Pigmented stools
Pale stools or not seen
Acholic stools
USS (4 hr fast)
Gallbladder normal
Gallbladder small or absent
Isotope excretion scan organised by liver unit team when ≥2 kg
Excretion
No excretion
Ongoing medical assessment with liver team, nutrition review, fat soluble vitamin supplementation and ursodeoxycholic acid
Urgent liver biopsy (may be performed at time of surgery)

Investigations for ongoing liver dysfunction

- If indicated by results of first line investigations or progressive dysfunction and on advice of liver team:
- ophthalmic review (other than for retinopathy of prematurity)
- microarray for dysmorphism
- karyotype
- very long chain fatty acids for neurological abnormality

- urinary bile salts
- other congenital infections screen
- isotope scan, liver biopsy or bone marrow aspirate

MANAGEMENT OF CHOLESTASIS

- Surgical correction, if appropriate (e.g. Kasai, choledochal cyst), usually when around 2 kg, discuss individual cases with liver unit team

Nutrition

- Seek nutritional review and ongoing nutritional advice from neonatal/liver dietitian
- If baby acutely unwell, stop all enteral feeds until galactosaemia excluded. Otherwise, continue mother's own breast milk, as available, +/- breast milk fortifier or preterm or term formula (as appropriate) while baby achieves adequate growth velocity

Babies with faltering growth:

Milk available	Preterm baby (<36 weeks)	Term baby (>2 kg)
Breast	Replace 25–50% feeds by volume with concentrated Aptamil® Pepti Junior*	Replace 25–50% feeds by volume with Infatrini® Peptisorb
Formula	Replace 25–50% feeds by volume with concentrated Aptamil® Pepti Junior	Replace all formula with Aptamil® Pepti Junior

*** Concentrated Aptamil® Pepti Junior (16%)**

- Add 4 level scoops Aptamil® Pepti Junior to 100 mL of cooled, boiled water and mix well
- Store in fridge until use, discard unused feed after 12 hr
- Per 100 mL: 79 kcal, 2.16 g protein, 1 mmol sodium
- If conjugated bilirubin >50 and baby not receiving parenteral lipid >10 mL/kg/day, start fat soluble vitamins in doses below:
  - vitamin K: 300 micrograms/kg/day (rounded to nearest 1 mg) oral (IV if acute liver failure) daily; monitor PT and APTT
  - vitamin A: 1000 units/kg/day (rounded to nearest 1000 units)
  - vitamin D: cholecalciferol 700units/kg/day (maximum dose 1000 units/day)
  - vitamin E: alpha-tocopherol 10 mg/kg/day
  - vitamin A, D, E levels to be measured 1 month after commencing treatment to ensure adequate dosing
- **DO NOT** give ABIDEC or Dalavit alongside fat soluble vitamins A, D, E, K

Ursodeoxycholic acid

- 10 mg/kg 3 times daily

Parenteral nutrition

- Wherever possible, feed enterally, as even small amounts have trophic effects on gut, reduce bacterial colonisation and promote bile flow
- Bolus feeds promote bile flow more readily than continuous feeds, but the latter may be better absorbed
- Refer to neonatal/paediatric or network dietitian for advice in babies who fail to make enteral progress
- If direct bilirubin >50 micromol/L, consider switching to SMOF lipid
- Discontinue PN as soon as possible in all preterm babies with cholestasis

Specific treatments

- Babies with cystic fibrosis, galactosaemia, tyrosinaemia type 1, hypopituitarism, hypothyroidism or bile acid disorders require additional targeted management and life-long follow-up shared by local teams and appropriate specialists

FOLLOW-UP

- For babies with persistent cholestasis, arrange outpatient follow-up with liver team after discharge from NNU
- If liver dysfunction has resolved, no follow-up with liver team necessary
- For all others with a specific diagnosis, follow-up will be directed by liver team, appropriate specialists and local consultant
- Long-term hepatic outcome for multifactorial preterm or neonatal hepatitis is excellent, majority resolve within first year

LONG LINE INSERTION (PERIPHERALLY SITED)● 1/5

A peripherally sited central venous catheter (PICC) allows administration of infusions that, if given peripherally, may cause damage to the vein and surrounding skin, or be less effective. These benefits must be weighed against the risks of line sepsis, thrombosis, embolism, and pleural and pericardial effusion. Units which use central line catheters should have a formal training package for insertion of catheters which should include assessment of technical competence and awareness of potential complications.

INDICATIONS

- Total/partial parenteral nutrition
- Concentrated (>12.5%) glucose infusions
- Concentrated calcium gluconate infusions
- Inotrope infusions
- Prolonged drug or fluid administration where peripheral access is difficult

RELATIVE CONTRAINDICATIONS

- Infection at proposed insertion site
- Sepsis
- Severe coagulopathy

BEFORE PLACEMENT

- Correct any significant coagulopathy
- if no evidence of bleeding tendency there is no requirement to routinely check FBC and coagulation profile
- Discuss platelet transfusion with consultant before line is placed, particularly if:
- platelet count <50 or
- evidence of excess bleeding from venepuncture sites
- If baby known/strongly suspected to be septic, discuss delaying placement of PICC line until sepsis under control with consultant

EQUIPMENT

- Sterile gown and gloves
- Cleaning solution as per unit policy
- Sodium chloride 0.9% for injection
- Tape measure
- Overhead light
- Neonatal long line – appropriate for size of baby and expected rate of infusion
- Nutriline® (single or double lumen) or Premicath® (with/without stylet)
- if flow rates to exceed 10–12 mL/hr, avoid Premicath®
- Long line insertion pack or, if not available, individual items to include:
- dressing pack with swabs and plastic dish
- sterile towels/sheets
- non-toothed forceps
- 5–10 mL syringe
- Steri-Strip™
- sterile scissors
- clear dressing (e.g. Tegaderm™/Opsite)

PROCEDURE

Must be performed or directly supervised by an individual competent in the insertion of these devices

Consent and preparation

- If non-emergency situation, explain to parents why procedure necessary and inform them of potential hazards
- provide information leaflets (if available)
- explicit consent not required
- Use 2-person technique with assistant observing the procedure for asepsis
- if available use departmental checklist to help maintain aseptic technique throughout procedure

- Discuss timing of procedure with nurses (in keeping with developmental care of baby)
- Keep baby warm, work through portholes
  - if procedure urgent use transwarmer
- Identify site of insertion
  - long saphenous at ankle or basilic (medial)/cephalic (lateral) veins at elbow
  - where access difficult, other large peripheral veins or scalp veins anterior to ear may be used
  - right long saphenous vein is preferable to the left – latter more commonly associated with malposition in the left ascending lumbar vein leading to risk of extravasation of PN into CSF
- Measure distance, aiming to insert tip of catheter into superior or inferior vena cava (to sternal notch for upper limb/head/neck insertion or to xiphisternum for lower limb insertion)

Developmental care

- Unless contraindicated, give sucrose or breast milk and non-nutritive sucking [see **Non-nutritive sucking (NNS)** guideline]
- Shield baby's eyes from bright light
- Second person to provide containment holding (see **Pain assessment and management** guideline)

Aseptic insertion

- Maintain strict asepsis throughout
- Prime catheter
- Clean site and allow to dry. Ensure that cleaning fluid does not pool beneath baby
- Puncture site with needle from pack and follow instructions for the catheter
- Avoid use of cannulae for long line insertion
- When blood flows back through the needle, insert line using non-toothed forceps
- If appropriately placed, the line will pass easily beyond the tip of the needle
- Release tourniquet if used
- May be some resistance when line passes joints e.g. knee, and gentle repositioning of limb may help
- Should catheter advancement become difficult, infuse a little fluid whilst simultaneously advancing catheter
- **Never** withdraw catheter back through needle
- When in place, withdraw needle as stated in catheter instructions
- Catheter should allow free aspiration of blood in the final position
  - with small size catheter (1 Fr), there may not be aspiration of blood into the syringe, however blood should appear in the catheter
    - tips of Premicath® with stylets preferred as easier to identify on X-ray
    - tips of 50% of non-stylet Premicath® are not visualized on routine X-ray – consider giving contrast media

Securing catheter

- Aim to minimize the risk of injury to the skin and potential catheter migration
- When haemostasis achieved, fix the looped line with Steri-Strips™ and cover with Tegaderm™/Opsite, making sure that all the long line and hub site is covered, but not encircling the limb tightly. Ensure line insertion site is visible through clear dressing
- Connect a sterile 5 mL syringe containing sodium chloride 0.9% and infuse at 0.5 mL/hr while awaiting X-ray, to ensure that the line does not clot

Determining catheter position

- X-ray to determine position
  - aim is to view full length of line
  - request chest/abdominal X-ray (including upper/lower limb requests as per local policy)
  - tip position influenced by arm placement; catheters placed in basilic (medial) vein move towards the heart on adduction, those placed in cephalic (lateral) vein move away from the heart
- If inserted in lower limb, ensure hip is slightly flexed
- Small gauge neonatal long lines can be difficult to see on plain X-ray
- Use X-ray magnification, contrast adjustment and inversion to aid process
- Use of radiopaque contrast medium may help in detection of some malpositioned catheters but cannot guarantee catheter correctly sited. Refer to local policy
- After any adjustment of catheter, repeat X-ray to confirm catheter tip position
  - post-processing radiograph should be available to help identify tip of catheter

- Optimal position for tip of PICC line: superior vena cava (SVC) or inferior vena cava (IVC) outside cardiac silhouette
- Upper limb catheter
  - tip should be above T4 in SVC
  - ensure tip of catheter crosses shoulder joint
- Lower limb catheter
  - tip should be in IVC below T9 and lie to right side of spinal column
  - ensure baby not rotated at when X-ray undertaken
  - if catheter inserted in the left lower limb does not cross the midline or has a tortuous course, the line may be in a small vessel. Lateral X-ray will demonstrate posterior deviation of the line towards the vertebral column
  - ensure tip of catheter crosses hip joint
  - if concern regarding possibility of malposition of catheter (see **Red flags for malposition**), seek consultant review
- Short long line
  - in few cases, PICC lines do not advance and are short of SVC or IVC, remaining in a smaller vessel or tributary. Long line in this position is prone to thrombosis and extravasation and may cause local injury. Sometimes necessary to use such a PICC line which sits in a large vein but short of preferred location (usually when no other suitable vessels identified to place alternative line)
    - ensure tip is within a large vein
    - ensure no other red flags (see **Red flags for malposition**)
    - ensure line samples blood. If not sampling/sampling with difficulty, withdraw line a short distance and try again
    - decision to use this line to be made by consultant
    - replace/remove lines in these positions as soon as practicable
- If catheter tip is beyond desired location, using aseptic technique, remove dressing and withdraw catheter the measured distance. Redress with new sterile dressing and confirm new position by X-ray
- Staff trained to use point of care ultrasound skills (POCUS) can use echocardiography to determine line position

Catheter tip must not lie within heart (risk of perforation and tamponade)

Red flags for malposition:

- PICC line:
  - 'sticks' during insertion and cannot be advanced to length anticipated
  - tip not clearly identified on X-ray, or lies at level of hip/shoulder joints
  - route not smooth, with kinks or sharp deviations
  - inserted in left leg and fails to cross midline to lie to right of spine
  - does not flush/sample
- Therapeutic infusions fail to have desired effect e.g. hypoglycaemia despite glucose infusion

Failure of insertion

- If second operator is required following an unsuccessful attempt at placement, use fresh equipment

DOCUMENTATION

- Record in case notes:
  - details of discussion with parents regarding PICC line insertion
  - name and designation of operator and anyone assisting/supervising procedure
  - date and time of insertion
  - type, number of lumens, and gauge of catheter used
  - batch number (insert tracking stickers)
  - site and length of insertion
  - success of insertion and number of attempts
  - X-ray position and if satisfactory
  - consultant neonatologist/paediatrician to verify position within 24 hr of insertion
  - any subsequent manipulation or re-imaging of line

AFTERCARE

Dressings and site care

- Routine dressing changes are unnecessary

- Replace aseptically only if dressings lift or catheter visibly kinked or becomes insecure
- Observe site every shift for bleeding, leaking of infusate and signs of infection (redness, swelling) and document in daily care summary

Line management and medication
- Minimise number of line breaks
- Intermittent medications only given via this route in extreme circumstances and should be a senior medical decision. Plan timing to match infusion changes
- When breaking into line, observe hand hygiene, wear sterile gloves and clean connection as per local infection control policy
- Change tubing used to give blood products immediately after transfusion (use to give blood product only if it is difficult to insert alternative IV line)

Position maintenance
- Repeat X-ray weekly to detect line migration
- Never routinely resite a line
- Review continued need on daily ward rounds and remove as soon as possible
- Comment on line position:
- when bedside echocardiography undertaken **or**
- if X-ray taken for any other reason

COMPLICATIONS

Clinical deterioration of a baby in whom a central venous catheter is present should raise the question of catheter related complications, particularly infection, extravasation and tamponade

Extravasation of PN to CSF can cause neurological symptoms (e.g. irritability, seizures, hypotonia). It is confirmed by presence of lipaemic CSF

Prevention
- Do not give blood products and medications routinely through long line and limit line breaks
- Avoid the use of small syringes (<2 mL) for bolus injections – generates high pressures which may result in catheter damage
- Avoid use of alcohol or acetone to clean catheter – may result in catheter damage
- Do not exceed pressure limits given by manufacturer – maximum infusion pressures vary for each line
- infusion pressures should not exceed 300 mmHg

Catheter-related sepsis
- Most common complication
- See **Infection (late onset)** guideline
- In cases of recent sepsis (if possible) wait ≥24 hr after removal of previously infected line before attempting new line insertion

Extravasation of fluids
- Into pleural, peritoneal, pericardial (above) and subcutaneous compartments
- Seek immediate advice from senior colleagues and follow **Extravasation injuries** guideline

Extravasation to CSF
- Most commonly associated with catheters placed in long saphenous vein
- Can cause varying neurological signs including irritability, abnormal movements, seizures and hypotonia
- Production of lipaemic fluid (either white “milky” coloured fluid or fluid with a high triglyceride content) in CSF is pathological and suggests this complication

Suspected/proven pericardial tamponade
- Have high suspicion in baby with acute deterioration, act quickly
- Suspect if any of the following symptoms:
- acute or refractory hypotension
- acute respiratory deterioration
- arrhythmias
- tachycardia/persistent bradycardia
- unexplained metabolic acidosis

- Confirm by X-ray (widened mediastinum, enlarged cardiac shadow) or by presence of pericardial fluid on echocardiogram
- Drain pericardial fluid (see **Pericardiocentesis** guideline) and remove catheter

Embolisation of catheter fragments

- Lines can snap if anchored within a thrombus
- If undue resistance encountered during removal, do not force
- Inform consultant, if accessible it may need surgical removal

Placement in artery

- Artery lies in proximity to vein – be aware of warning signs suggestive of inadvertent cannulation of artery:
  - pulsation of blood either in introducer or PICC line
  - arterial blood sample (analysed in blood gas analyser) aspirated from line
  - blanching of skin as needle pierces artery around insertion site
  - blanching of limb distal to site of insertion
- If cannulated artery suspected, seek consultant opinion and do not use line until correct placement confirmed
- If limb becomes ischemic, remove line immediately

REMOVAL

Indications

- Clinical use is no longer justified
- Currently no evidence for early elective removal of the line and replacing it to prevent infection
- Proven line infection
  - if suspected, may need to be removed
- Remove 24 hr after stopping parenteral nutrition to ensure tolerance to full enteral feeds, run glucose 10% through line at 0.5 mL/hr to maintain patency

Technique

- Using aseptic technique:
  - remove adhesive dressing very carefully
  - pull line out slowly, using gentle traction in the direction of the vein, grasping line not hub
  - ensure catheter complete
  - if clinical suspicion of line infection, send tip for culture and sensitivity
  - apply pressure to achieve haemostasis
  - document removal in notes

MASSIVE HAEMORRHAGE ● 1/3

RECOGNITION AND ASSESSMENT
- Rare but potentially fatal neonatal event

DEFINITION
- Actual/suspected blood loss with haemodynamic instability or
- Blood loss >2 mL/kg/hr

CAUSES
- Occult haemorrhage
  - fetal to maternal transfusion
  - twin-to-twin transfusion
- Placenta
  - placenta praevia/abruption
  - vasa praevia
  - umbilical cord injury/damage
- Baby
  - intracranial haemorrhage
  - cephalohaematoma, subgaleal haemorrhage
  - GI bleed
  - Pulmonary haemorrhage
- Factors predisposing to haemorrahge: coagulopathy secondary to sepsis/DIC/acute liver failure, vitaminK deficiency

SIGNS
Hypovolaemia
- High/increasing heart rate (>160 bpm)
- Low/falling Hb or haematocrit
- Poor peripheral perfusion with slow central capillary refill (>3 sec)
- Low or falling blood pressure [mean blood pressure (MBP) <40 mmHg in a term baby]
- Presence of, or worsening, metabolic acidosis
- Echocardiography (if available) to assess volume status
  - small systemic veins and low ventricular filling volumes can indicate hypovolaemia

INVESTIGATIONS
- Crossmatch
- FBC
- PT
- APTT
- Fibrinogen
- U&E
- Ionised calcium
- Blood gases
- If feto-maternal haemorrhage suspected, request maternal Kleihauer test

Hb can be normal due to lack of dilutional effect – do not view as reassuring

IMMEDIATE TREATMENT
Key principles of management
- Timely recognition of major haemorrhage
- Control of haemorrhage and active resuscitation
- Emergency vascular access
- Early escalation to major haemorrhage pathway and to consultant
- Immediate transfusion of packed red cells, platelets and FFP
- Avoid hypothermia, hypocalcaemia, acidosis and hyperkalaemia
- Follow **Major haemorrhage pathway (MHP)** – see below

Group O RhD negative blood can be used whilst awaiting massive haemorrhage protocol blood products –
ALWAYS available on labour suite/obstetric theatres

Table 1: Products

Product	Unit
RBC (20 mL/kg)	Paediatric (<100 mL)
Plasma (20 mL/kg)	Neonatal fresh frozen plasma (100 mL)
Platelets (20 mL/kg)	Paediatric platelets (50 mL)
Cryoprecipitate (10 mL/kg)	Single donor (40 mL)

Table 2: Paediatric major haemorrhage pack contents

	Pack 1	Pack 2
Packed red cells	✓	✓
FFP	✓	✓
Platelets		✓
Cryoprecipitate		✓

- **Note: Pack contents** – these are not packs that actually exist, but provide a way of thinking through what should be needed in suitable ratios. Many centres will need to design and implement a local protocol between haematology and neonatal teams to plan for this eventuality, based on this structure and flowchart

SUBSEQUENT MANAGEMENT

- The following may be necessary, discuss with neonatologist:
- elective intubation and ventilation (following resuscitative blood and blood product replacement)
- inotropic support
- thermoregulation
- monitor and correct electrolyte and metabolic imbalance (hypocalcaemia, hyperkalaemia)

DISCHARGE AND FOLLOW-UP

- Neurodevelopment follow-up for long-term neurological outcome

MASSIVE HAEMORRHAGE • 3/3

Flowchart: Major haemorrhage pathway (MHP)

Actual/suspected blood loss with haemodynamic instability OR blood loss >2 mL/kg/hr

Resuscitate
- ABC + apply oxygen
- Fluid warmer and incubator/overhead heater care
- Continuous monitoring:
  - BP (regular intervals)
  - cardiac
  - oxygen saturations

Baseline tests
- Crossmatch, FBC, PT, APTT, fibrinogen, U&E, ionised calcium, blood gases

Stop the bleeding
- Manual interventions
  - if applicable use external pressure

Activate MHP
- Notify transfusion laboratory
- State paediatric major haemorrhage
- Provide full patient details including:
  - weight
  - location
- Provide team contact details

Team roles:
- Team leader:
  - co-ordinates care, decides management/treatment
  - allocates roles
- Communication lead:
  - liaises with laboratory and support services
- Scribe:
  - takes samples
  - orders investigations
  - documents management
- Runner:
  - collects samples/delivers products (porter ordered by transfusion laboratory at time of activation) to clinical area ≤20 min)

- Allocate team roles
- Inform paediatric consultant
- If clinically indicated – group O RhD negative red cells
- Administer PMH pack 1 in aliquots of 10 mL/kg and in a ratio of 1:1 (red cells:FFP) simultaneously via Y-connector

- Constantly assess extent of bleeding and response to treatment to dictate management
- Repeat baseline laboratory tests every 30–60 min if ongoing bleeding

Bleeding controlled?

YES

- Stand down paediatric major haemorrhage
- Notify transfusion laboratory and return unused products

NO

- Administer PMH pack 2
  - if mixing post-filter – through separate line or via Y-connector
- If already administered PMH pack 2 and bleeding not controlled alternate between packs 1 and 2 until aims achieved
- Careful monitoring for adequacy of resuscitation and for circulatory overload is essential

REASSESS

Aims
- Hb >120 g/L
- Platelets >100 × 10^9/L
- Fibrinogen >1.2 g/L
- PT/APTT ratio <1.5 (1.8 preterm)
- Ionised Ca^{2+} >1.0 mmol/L
- Normokalaemia
- Normothermia
- pH >7.35 (on ABG)
- MBP ≥gestational age

MEDIUM-CHAIN ACYL-COA DEHYDROGENASE DEFICIENCY (MCADD) – EARLY MANAGEMENT OF BABIES WITH FAMILY HISTORY ● 1/1

See British Inherited Metabolic Disorders Group (BIMDG) Guideline: **Management of newborn babies who might potentially have MCAD deficiency** (https://bimdg.org.uk/)

DEFINITION

- Inherited disorder of fat metabolism
- With regular intake of food, individuals can lead a normal healthy life but prolonged fasting or illness with vomiting can lead to encephalopathy, coma or sudden death
- Hypoglycaemia is a late sign
- Babies with a family history of MCADD require a special feeding regimen and observation from birth
- Families of newborn babies with family history of MCADD should have already received correspondence from specialist metabolic centre in advance of birth, regarding additional feeding support/investigations required

BACKGROUND

- When mother admitted in labour, inform neonatal team
- When baby aged 24–48 hr, carry out following tests:
  - bloodspot acylcarnitines
  - urine organic acids
  - DNA mutation analysis [in most cases, specific genotype will be known for the index case – write this (and details of index case) on molecular genetics form]
- Discuss testing with metabolic laboratory at Birmingham Children's Hospital and mark request 'family history of MCADD'.
- If baby on glucose IV at time of sampling, repeat acylcarnitine sample **must** be taken after 24 hr of full feeds (to avoid false negative)
- Ensure full routine newborn bloodspot screening completed on day 5

MANAGEMENT

- Any at risk baby **must** receive sufficient milk intake to avoid potential for decompensation while awaiting results
- Specific feeding advice depends on whether baby is bottle/breastfed
- See **Management of newborn babies who might potentially have MCAD deficiency** (https://bimdg.org.uk/) for specific feeding guidance

PROBLEMS

- **If baby becomes drowsy or unwell in any way, admit to NNU urgently**
- Follow **Management of newborn babies who might potentially have MCAD deficiency** (https://bimdg.org.uk/)
- Seek urgent advice from specialist metabolic centre

DISCHARGE

- Assess baby's feeding; ensure reliably feeding well before considering discharge – continue special feeding regimen until results available
- If baby feeding well, risk of neonatal decompensation is low after 72 hr
- Baby can be safely discharged before this, even if results are not known, provided feeding well
- Give parents clear safety-netting instructions – return to hospital if feeding is poor

LOCAL CONTACT

- For specialist advice, consult on-call metabolic registrar/consultant via Birmingham Children's Hospital switchboard (0121 333 9999)

FURTHER INFORMATION

BIMDG website: http://www.bimdg.org.uk/guidelines.asp

METABOLIC BONE DISEASE (MBD) ● 1/2

RECOGNITION AND ASSESSMENT

Definition

- Decreased mineralisation of bones due to deficient phosphate (PO_4), calcium (Ca) or vitamin D in preterm babies
- Also known as osteopenia of prematurity

Causes

- Inadequate postnatal intake or absorption to match intrauterine mineral accretion rate

Risk factors

- <32 weeks' gestation or <1500 g birth weight
- Male gender
- Delay in establishing enteral feeds/enteral feeds with low mineral content/bioavailability [unfortified expressed breast milk (EBM), term formula]
- PO_4/Ca or vitamin D deficiency
- Prolonged parenteral nutrition (PN) (>2 weeks)
- Chronic drug use that increases mineral excretion (diuretics, steroids, sodium bicarbonate)
- Lack of mechanical stimulation e.g. sedation/paralysis
- Chronic lung disease
- Cholestatic jaundice
- Short gut syndrome (malabsorption of vitamin D and Ca)

Signs

- ≤6 weeks – most babies are asymptomatic and normal on examination
- Usually presents aged 6–12 weeks
- Poor weight gain or faltering growth
- Respiratory difficulties: failure to extubate due to increased chest wall compliance
- Fractures with minor or no trauma; may manifest as pain on handling
- Craniotabes (softening of skull bones)

Later clinical consequences

- Marked dolicocephaly (long and narrow skull)
- Reduced linear growth

DIAGNOSIS

Serum biomarkers

- Low serum PO_4 (<1.8 mmol/L) with elevated alkaline phosphatase (ALP) (>900 IU/L) is 100% sensitive and 70% specific for diagnosing low bone mineral density
- Low serum PO_4 concentrations (<1.8 mmol/L) have 96% specificity but only 50% sensitivity. Routine PO_4 supplementation in high risk babies could lead to secondary hyperparathyroidism, and thus worsen MBD
- Serum Ca levels may remain normal until late in the disease despite bone losses of Ca
- In suspected MBD with elevated ALP and low PO_4, serum parathormone (PTH) measurement will help in establishing if there is underlying Ca or PO_4 deficiency to provide correct supplementation
  - Ca deficiency causes increased PTH to maintain normocalcaemia
  - in PO_4 deficiency there is no compensatory mechanism – PTH remains normal

Urinary biomarkers:

- Urinary excretion of Ca >1.2 mmol/L and PO_4 >0.4 mmol/L signifies slight surplus of supply and correlates with highest bone mineral accretion rate
  - phosphaturia can occur due to aminoglycoside, indomethacin and steroid therapy
  - calciuria can occur due to diuretics, steroids and theophylline
- Tubular reabsorption percent (TRP) of PO_4 is also a guide to adequacy of PO_4 supplementation. TRP of >95% indicates inadequate supplementation
  - TRP (%TRP) = [1 − (urine PO_4/urine creatinine) (plasma creatinine/plasma PO_4)] × 100

Radiological

- Low bone density on X-rays (rachitic changes, cortical thinning, periosteal elevation) or fractures of long bones or ribs
- Dual-energy X-ray absorptiometry/qualitative ultrasound to assess bone mineral density

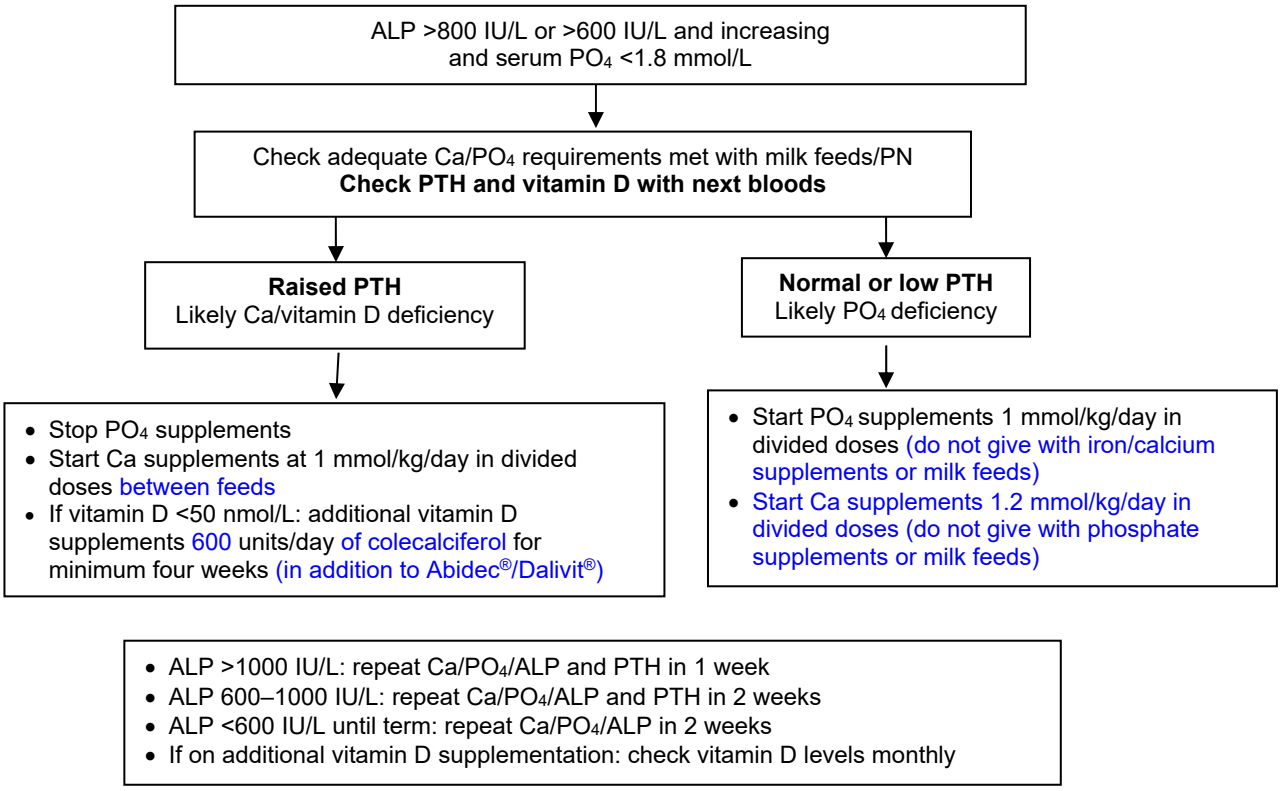
METABOLIC BONE DISEASE (MBD) ● 2/2

PREVENTION

- Optimal nutritional intake
- early PN with optimised Ca and PO_4 content – see **Parenteral nutrition** guideline
- early enteral feeds
- optimal ratio of enteral Ca:PO_4 of 1.3:1 – ≤1.4:1 mmol-to-mmol basis should be targeted to avoid secondary hyperparathyroidism
- adequate Ca (3–5.0 mmol/kg/day) and PO_4 (2.2–3.7 mmol/kg/day) intake by using fortified EBM or preterm formula. ≥140 mL/kg/day fortified EBM or preterm formula is needed to provide this
- daily intake of ≥400–700 units/kg/day vitamin D
- Ensure appropriate handling and position using deep boundaries to promote active bone loading

INVESTIGATION AND TREATMENT:

For all high risk babies, after ≥1 week of full enteral feeds (≥140 mL/kg/day fortified EBM or preterm formula), measure serum Ca, PO_4 and ALP levels from third week of life and follow this guidance:


ALP >800 IU/L or >600 IU/L and increasing
and serum PO4 <1.8 mmol/L
Check adequate Ca/PO4 requirements met with milk feeds/PN
Check PTH and vitamin D with next bloods
Raised PTH
Likely Ca/vitamin D deficiency
Normal or low PTH
Likely PO4 deficiency
• Stop PO4 supplements
• Start Ca supplements at 1 mmol/kg/day in divided doses between feeds
• If vitamin D <50 nmol/L: additional vitamin D supplements 600 units/day of colecalciferol for minimum four weeks (in addition to Abidec®/Dalivit®)
• Start PO4 supplements 1 mmol/kg/day in divided doses (do not give with iron/calcium supplements or milk feeds)
• Start Ca supplements 1.2 mmol/kg/day in divided doses (do not give with phosphate supplements or milk feeds)

- ALP >1000 IU/L: repeat Ca/PO_4/ALP and PTH in 1 week
- ALP 600–1000 IU/L: repeat Ca/PO_4/ALP and PTH in 2 weeks
- ALP <600 IU/L until term: repeat Ca/PO_4/ALP in 2 weeks
- If on additional vitamin D supplementation: check vitamin D levels monthly

NOTE:

- Do not give Ca and PO_4 at the same time as they may precipitate;
- Do not give Ca or PO_4 supplements with feeds
- Ca supplementation can cause intestinal obstruction and hypercalcinosis
- Regular monitoring of urinary Ca/urinary creatinine ratio necessary to detect hypercalciuria (urinary Ca/urinary creatinine) >0.6
- Consider other nutritional deficiencies e.g. zinc, in a baby with faltering growth with evidence of significant bone disease

MONITORING AND FOLLOW-UP

- Stop additional vitamin D when vitamin D and PTH are normal
- Adjust Ca dose based on serum Ca levels and stop only once PTH levels normalise
- Adjust PO_4 dose,based on serum PO_4 levels, and ALP adjusting Ca dose to maintain ratios
- Continue treatment until biochemical indices are normal and radiographic evidence of healing, usually until term corrected gestation

MICROCEPHALY ● 1/2

- Present at birth and occurs in approximately 3 per 10,000 births
- also known as primary microcephaly
- Defined as head circumference [occipital frontal circumference (OFC)] <2nd centile on the growth chart (severe if <0.4th centile)
- Check whether microcephaly is symmetrical (proportionate to body weight) or asymmetrical
- May indicate significant underlying structural brain abnormality, genetic or metabolic condition, or congenital infection
- Does not necessarily predict functional outcome but can be associated with seizures, cerebral palsy, developmental delay, hyperactivity depending on underlying aetiology

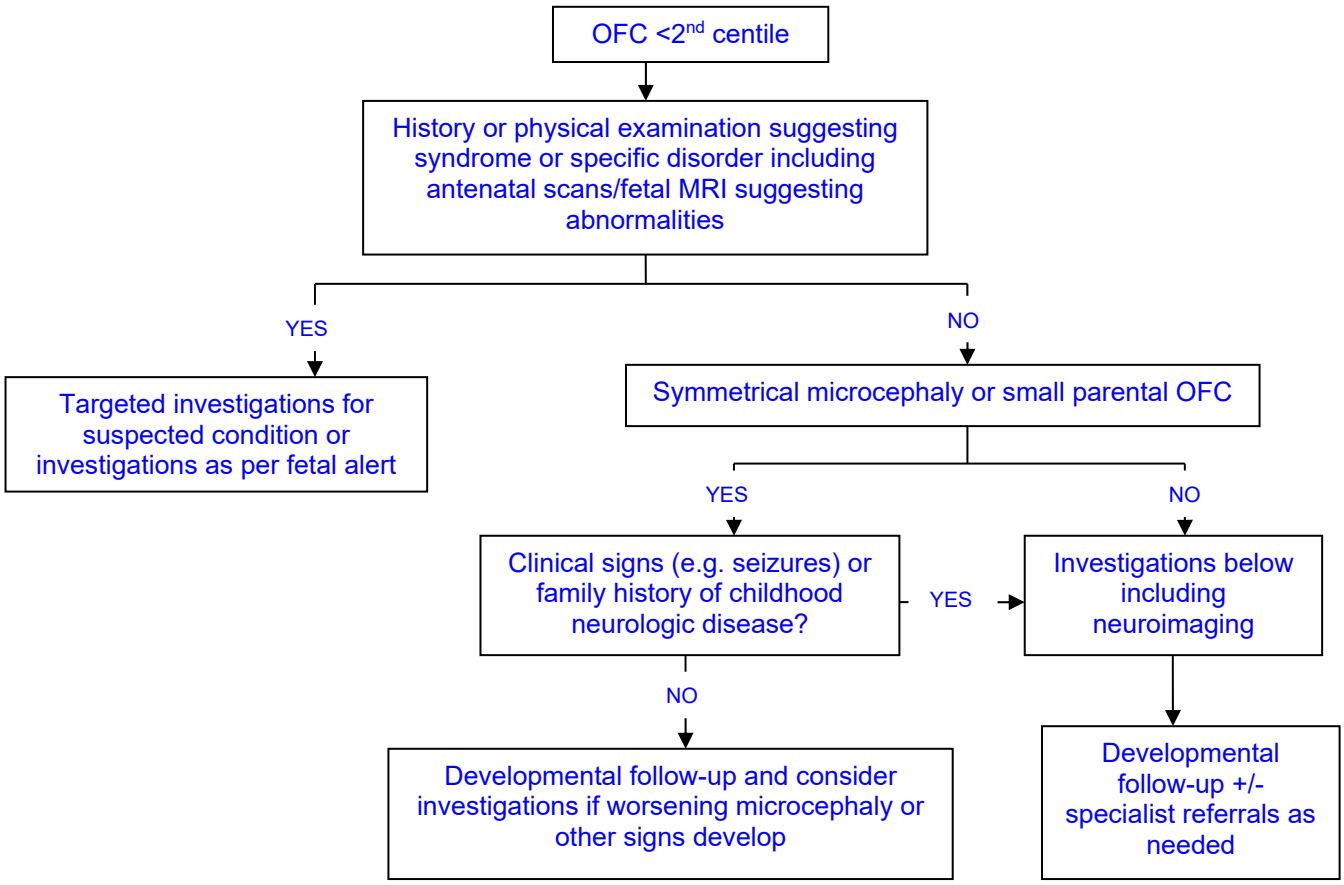
CAUSES

- Aetiology unknown in 40% of cases
- Known aetiology can be broadly categorised as due to premature fusion of sutures (i.e. craniosynostosis) or poor brain growth
- Causes include:
- genetic or chromosomal anomalies e.g. Smith-Lemli-Opitz syndrome, trisomy 13, trisomy 18, trisomy 21, Cornelia de Lange syndrome, Rett syndrome, Cri du chat syndrome, Williams syndrome
- structural or neuroanatomical abnormalities in the brain
- metabolic e.g. pyruvate dehydrogenase deficiency, serine biosynthesis disorder
- intrauterine infections e.g. SCORTCH (syphilis, cytomegalovirus, 'other', rubella, toxoplasmosis, chickenpox, herpes simplex virus and blood-borne viruses), Zika virus, varicella zoster virus, human immunodeficiency virus, lymphocytic choriomeningitis virus (LCMV)
- teratogens e.g. alcohol, cocaine, anti-epileptic drugs, lead/mercury intoxication, radiation
- stroke or death of a twin in-utero
- maternal diseases e.g. hyperphenylalaninaemia, anorexia nervosa, placental insufficiency, hypothyroidism, malnutrition in pregnancy

MANAGEMENT

- Detailed history including:
- prenatal
  - maternal medical history
  - medication/substance misuse exposure in pregnancy
  - antenatal blood and ultrasound scan results
  - travel history of both parents in last 6 months before/during pregnancy
  - family history of inherited conditions
- perinatal
  - gestational age
  - birth weight
  - need for resuscitation at birth
  - risks for infection
- Physical examination
- assess for dysmorphic features
- measure and plot head circumference and weight on growth chart
- where feasible, measure OFC 24 hr after birth to account for effects of moulding, caput succedaneum and cephalhaematoma

INVESTIGATIONS


OFC <2nd centile
History or physical examination suggesting syndrome or specific disorder including antenatal scans/fetal MRI suggesting abnormalities
YES
NO
Targeted investigations for suspected condition or investigations as per fetal alert
Symmetrical microcephaly or small parental OFC
YES
NO
Clinical signs (e.g. seizures) or family history of childhood neurologic disease?
YES
Investigations below including neuroimaging
NO
Developmental follow-up and consider investigations if worsening microcephaly or other signs develop
Developmental follow-up +/- specialist referrals as needed

Viral screen: SCORTCH screen (including urine CMV)

- If mother had negative SCORTCH screen in pregnancy to investigate microcephaly, this should suffice
- if mother travelled to endemic countries in pregnancy or ≤6 weeks before pregnancy (6 months for male partners), consider Zika virus screen

Microarray

- 44% of congenital microcephaly associated with genetic aetiology

MRI head

- Detects abnormalities in approximately 80% of severe microcephaly
- Cranial USS has limited role as excludes mainly gross cortical malformation

Metabolic tests

- Not routinely indicated as first line – metabolic disorders are more likely to cause secondary microcephaly
- Ensure Guthrie test done and results are normal (checks for some inborn errors of metabolism)
- If suspected, toxin screen for heavy metals e.g. lead, arsenic and mercury

TREATMENT

- Management depends on severity and underlying cause
- Severe cases more likely associated with imaging abnormalities or development delay and support services e.g. occupational or physical therapy, speech and language can optimise outcomes
- If associated with seizures (see **Seizure** guideline), anticonvulsants may be required

MONITORING AND OBSERVATIONS ON NEONATAL UNIT ● 1/2

- Guideline offers guidance to monitor and record SpO_2, cardiac (ECG) and blood pressure for babies admitted to NNU
- May be superseded by clinician discretion based on circumstances – more frequent assessment may be required than mentioned below
- All babies requiring admission to NNU to have baseline observations within first hour
- Clearly document decision to discontinue monitoring in medical records
- Guidance below serves as reference for ongoing monitoring and recording of observations, as well as when to stop

PERIPHERAL SpO_2

Frequency and eligibility for subsequent monitoring

Hourly/continuous monitoring and hourly documentation

- All acutely unwell babies whose physiological status is unstable/unknown

When to stop monitoring

Term babies

- If oxygen requirement transient (< first 24 hr of life), then continue monitoring depending on highest level of respiratory support required
  - incubator/low flow supplementation – **minimum** 4 hr
  - high flow/CPAP/NIPPV – **minimum** 12 hr
- If oxygen requirement beyond first 24 hr of life, continue monitoring for following period from discontinuation of any respiratory support
  - 24 hr: babies born at term gestation (≥37 weeks)
  - 48 hr: babies born 34–36^{+6} weeks gestation

All babies born <34 weeks' gestation

- Continue monitoring and documentation **until 34 weeks'** CGA
  - to continue at least ≥48 hr after discontinuing caffeine citrate

If oximetry study indicated

- Continue saturation monitoring and documentation until study reported satisfactory

Special considerations

- Following LASER ablation of ROP, follow relevant SOP
- Continue monitoring and documentation:
  - post-immunisation: for 48–72 hr after injections
  - RSV immunisation (Palivizumab): for 24 hr after injection

BLOOD PRESSURE

Frequency and eligibility for subsequent monitoring

Hourly/ continuous monitoring and hourly documentation

- All acutely unwell babies whose physiological status unstable/unknown
- All babies with indwelling peripheral/umbilical arterial line
- All babies on inotropes/vasoactive medications

2-hrly monitoring and documentation

- Minimum of 48 hr after extubation and/or discontinuing all inotropes
- If observations remain stable, monitoring may be stretched to 4-hrly

Twice daily monitoring and documentation

- Babies born <32 weeks' gestation or <1250 g: in first week of life

Once daily monitoring and documentation

- Babies born <32 weeks' gestation or <1250 g: on/after day 8 of life
- Babies born >32 weeks' gestation to 34 weeks' CGA or until discontinuation of continuous SpO_2 monitoring (whichever is later)

When to stop monitoring

- See above

Special considerations

- Post-LASER ablation for ROP, follow relevant SOP
- On postnatal steroids for CLD: twice daily until discontinued
- Oxygen dependency and >28 days of life: weekly once blood pressure monitoring
- Medications (captopril, sildenafil, thyroxine, diuretics, diazoxide):12–24 hourly as directed by clinician
- Blood transfusion: hourly monitoring during transfusion continued at least until ≥2 hr after completion
- Be more mindful of monitoring and consider more frequent observations for the following conditions/situations:
  - congenital heart disease: repaired/unrepaired
  - known renal disease/urological malformations
  - malignancy
  - suspected neurofibromatosis or tuberous sclerosis
  - list is not exhaustive and individual practice variation under special circumstances may be allowed to require more frequent monitoring as directed by clinician

Difficulties in measuring non-invasive blood pressure

- If non-invasive blood pressure cannot be measured, attempt using different cuff size/limb site
  - if still unable to measure, escalate immediately to medical staff for further plan for evaluation and management including frequency of assessment
    - may include assessment of end-organ perfusion and possible requirement of volume replacement and/or inotropes depending on situation

CARDIAC MONITORING (ECG)

Frequency and eligibility for subsequent monitoring

Continuous monitoring with hourly documentation in health records

- All babies on any respiratory support
- Babies receiving blood transfusion
- Babies being evaluated and/or treated for cardiac arrhythmias

When to stop monitoring

- Until 48 hr after cessation of caffeine citrate (usually 34–35 weeks' CGA)

Special considerations

- Babies receiving blood transfusion: ≥2 hr after the completion of transfusion

MULTI DRUG RESISTANT ORGANISM COLONISATION (MRSA, ESBL etc.) ● 1/3

Use this guideline in conjunction with your local Trust policy

This guideline describes the screening and follow-up action for the following organisms:

- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Multi-resistant Gram-negative bacilli (MGNB) including:
  - extended spectrum beta lactamase (ESBL)-producing Enterobacterales
  - carbapenemase-producing Enterobacterales (CPE)
  - other carbapenemase-producing multi-drug resistant GNB

SCREENING

Babies transferred from other hospitals

- Screen on arrival. Include babies who attend other hospitals for invasive day case procedures (e.g. PDA ligation)
- MRSA:
  - swab nose and perineum plus umbilicus if still moist, and swab any skin lesion (e.g. indwelling vascular line)
  - urine if long-term urinary catheter present
- MGNB:
  - obtain rectal swab or swab from stool sample; swab must contain visible faecal material to ensure a reliable screening result
  - urine if long-term urinary catheter present
- Barrier nurse until **all** swabs confirmed negative at 48 hr

Routine screening on unit

- MGNB: monthly
- MRSA: monthly
- Frequency of screening may be increased on advice of lead infection prevention doctor/ infection prevention team if unexplained acquisition of MRSA and/or MGNB occurred on ward

Infection control alerts

- Infection control alert to be triggered for 2 yr after last positive result, irrespective of any negative follow-up screens
- Babies colonised with CPE and other carbapenemase-producing GNB require an infection control alert to be displayed for 5 yr after the last positive result, irrespective of any negative follow-up screens
- Babies identified by infection prevention team as a close contact of a baby with CPE will require a patient infection control alert up to 5 yr; can be removed when 3 follow-up screens for MGNB, submitted since the creation of the alert, reported as 'MGNB **not** isolated'

MANAGEMENT OF INCIDENTAL FINDINGS

If new case MRSA reported in patient, offer screening for MRSA:

Mother

- Screen mother with nasal, perineal, wound and skin lesion swabs, if any of the following:
  - delivery by caesarean section
  - mother had recent admission to hospital before delivery
  - mother has chronic health problem (e.g. diabetes mellitus, asthma)
  - mother has other risk factor, high BMI or is a healthcare worker with patient contact
  - mother or household member has a history of skin/soft tissue infection abscess or recurrent skin infections in the last 12 months
- If none of these risk factors present, screening contacts is not necessary unless advised by consultant microbiologist

Contacts on NICU (patients only):

- Those who have been in close proximity of the index case (i.e. in the same room)
- Potentially all babies on the ward following a risk assessment and discussion with consultant of the week, co-ordinator, infection prevention team and consultant microbiologist
- Healthy babies about to be discharged home do not require screening unless advised by consultant microbiologist

Decolonisation of MRSA carriers

- Discharge term healthy babies without decolonisation treatment
- Smaller babies with indwelling lines or CPAP probes are more at risk of infection and should be treated
- Decolonisation may fail due to presence of indwelling lines/foreign body material; repeat once all indwelling lines/foreign bodies removed
- mupirocin (Bactroban Nasal®) ointment applied to inner surface of each nostril 3 times daily for 5 days; if MRSA reported as high level resistant to mupirocin discuss with consultant microbiologist
- wash daily with antimicrobial wash, e.g. chlorhexidine or octenidine, for 5 days
- Repeat screening swabs 48 hr after all antibiotic treatment has finished and if baby not about to be discharged
- Successful eradication can be assumed if 3 consecutive swabs taken at 3–7 day intervals are negative. Do not attempt to decolonise more than twice during any 1 admission

MGNB

- Do not attempt decolonisation. Do not treat asymptomatic rectal carriage. Colonisation is in the gut. Drugs are ineffective – may severely damage gut flora and encourage development of resistant organisms
- MGNB: gut carriage not permanent, however may last for several months to years
- barrier nurse until discharge

MANAGEMENT OF OUTBREAK

MRSA

- ≥2 babies with same strain of MRSA constitutes an outbreak
- considered 'the same' if they have been sent by microbiology to a reference laboratory for typing and have been reported by reference laboratory as 'indistinguishable'

Action on advice of infection prevention team

- Screen all babies in NNU (swabs as above)
- Optimise infection control measures: see **local infection control policy**
- If further cases of the same strain occur:
- arrange incident meeting to discuss further measures, e.g. swabs from all clinical staff on unit
- If contact screening of clinical staff for MRSA recommended by lead infection prevention doctor/consultant microbiologist, to be co-ordinated by infection prevention team in collaboration with occupational health (OH)
- results sent to OH and infection prevention team
- contact screening for MRSA of healthcare workers must follow local infection prevention guidance

MGNB

- ≥2 babies with same type of MGNB/CPE constitutes an outbreak
- considered 'the same' if sent by microbiology to reference laboratory for typing, and reported as 'indistinguishable'
- For CPE ≥2 babies with the same carbapenemase gene (OXA-48, KPC, VIM, NDM-1 etc.) irrespective of organism if associated in time and space constitutes an outbreak

Action

- Screen all babies in NNU on advice of infection prevention team
- Optimise infection control measures: see **local infection control policy**
- If further cases of same strain occur arrange incident meeting to discuss further measures e.g. environmental screening etc.

CPE

- Screen all contacts (should be alerted on local hospital system)
- 3 rectal swabs/swab from stool sample, ≥24 hr apart
- if baby on antibiotics: take ≥1 swab >48 hr after stopping antibiotics
- if all 3 swabs negative: clear of CPE contact status
- if any swab positive, following required:
  - strict isolation
  - long sleeved gowns
  - gloves
  - barrier nursing
  - barrier cleans

MULTI DRUG RESISTANT ORGANISM COLONISATION (MRSA, ESBL etc.) ● 3/3

- Barrier nurse all colonised babies until discharge
- Ensure strict infection prevention measures in place for all babies identified as CPE contacts/with close contact alert
- If CPE reported during current hospital admission:
  - strict infection prevention measures to remain in place (irrespective of any negative follow-up screens)
  - follow-up screens not required
  - if baby discharged whilst being investigated as contact, follow-up rectal swabs in the community are not required
  - if readmitted whilst having a close contact alert, commence/continue follow-up MGNB screening and repeat on different days until 3 follow-up screens have been reported as ‘MGNB **not** isolated’
  - close contact alert will remain on hospital system for 5 yr, unless 3 follow-up screens reported as ‘MGNB **not** isolated’

MYELOMENINGOCELE (MMC) ● 1/2

DEFINITION

- Defect of the backbone and spinal cord
- MMC is the most serious type of spina bifida; spinal cord and meninges push out and create a sac in baby's back
- Associated with significant damage to spinal cord
- Can leave nervous system vulnerable to life-threatening infection

MANAGEMENT

Antenatal diagnosis

- Refer to neurosurgery team
- Offer parents appointment with neurosurgeon before the birth

Post-delivery

Neonatal management in local unit:

- Systemic management: as per local unit guideline
- First line antibiotics: see **Infection in first 72 hours of life** guideline
- Give vitamin K
- Nurse prone/lateral, irrespective of gestation and ventilator status
- Baseline cranial ultrasound
- Occipital frontal circumference (OFC) daily before transfer

Specific MMC management

Open MMC

- Surgical closure recommended in first 24–48 hr
  - transfer to appropriate surgical unit ≤24 hr (providing condition stable)
  - if flap closure required neurosurgeon to refer to plastic surgeon
- Protect exposed meninges until surgical closure performed. Immediately after delivery cover lesion with non-adherent silicone dressing e.g. Mepitel®, followed by sodium chloride soaked gauze. Cover with cling film
  - do not place gauze in direct contact with exposed meninges – can cause tearing and leaking of CSF as gauze dries out and sticks to meninges
  - if gauze becomes dry, moisten with sodium chloride, keeping Mepitel® in place
  - if baby nursed in incubator, adequately soak gauze and check 4-hrly
  - if gauze becomes soiled with faeces or urine, change immediately
  - nurse baby prone/lateral
  - do not dress baby – may cause injury to lesion
- If evidence of hydrocephalus, cerebral spinal fluid (CSF) diversion will be considered at time of closure
  - avoid contact with products containing latex; high risk (25–65%) of developing latex sensitisation and allergy
  - complete red allergy band with 'latex precautions' and place sign above bed
  - inform theatres of latex precautions at time of booking
- Risk of hydrocephalus, daily monitoring of:
  - OFC
  - depth and softness of anterior fontanelle
- Document daily on centile chart:
  - head circumference
  - weight
- Document pre-operative administration of vitamin K and completed screening tests on neonatal checklist

Closed MMC or had in-utero repair

- Discuss with neurosurgeons regarding recommended timings for investigations, surgery and follow-up
- Risk of hydrocephalus
  - monitor head circumference (request cranial USS and MRI)
- Risk of neurogenic bladder/bowel
  - ensure passed urine and faeces (request renal USS)

MYELOMENINGOCELE (MMC) ● 2/2

PRE-OPERATIVE INVESTIGATIONS AND MANAGEMENT

- Protect lesion from soiling and contamination
- Nurse baby prone/lateral
- Apply minimal tape to skin due to sensitivity to tapes, and to prevent epidermal stripping
- Bloods for:
  - FBC
  - U&E
  - clotting
  - group and save
- Ultrasound of renal system
- MRI of head and spine at earliest opportunity as baseline (if possible pre-operatively, but do not delay surgery for imaging)
- Consider clinical photography before and after repair
- obtain consent at time of consenting for surgery

DISCHARGE

- Provide parents with wound care advice
- Advise first bath 7–10 days post-operatively (unless advised otherwise)
  - if no concerns regarding wound, baby bath solution can be used
- Neurosurgical clinical nurse specialist to provide information regarding shunt malfunction
  - if no shunt present, ensure parents made aware of signs and symptoms of hydrocephalus
- Liaise with health visiting team to:
  - arrange regular OFC measurement
  - share contact information
  - ensure safe infant sleeping/SIDS guidelines taught
- Arrange follow-up appointments
  - neurosurgery ward clinic: 1 week post-discharge
  - named consultant clinic: ≤6–8 weeks post-discharge
  - urology/urodynamics: book before discharge (including ultrasound appointment)
- Refer to community paediatrician
- Provide parents with contact details of neurosurgical clinical nurse specialist
  - clinical nurse specialist to provide copy of SHINE charity booklet, with additional team names completed
- Detailed discharge summary made and given to parents
- Refer to physiotherapy service

NASOGASTRIC TUBE ADMINISTRATION OF FEED, FLUID OR MEDICATION● 1/2

Procedure is the same for nasogastric and orogastric tubes. As nasogastric tubes (NGT) are more commonly used in babies, the term nasogastric will be used throughout this guideline

INDICATIONS

- Contraindications to oral feeding, or baby unable to take full requirements orally
- Nasogastric or orogastric tube in place

EQUIPMENT

- Enteral syringes
- pH testing strips
- Gravity/bolus feeding set
- Feed/fluids/medication according to prescription
- Prescription (for medication)

PROCEDURE

Preparation

- See **Nasogastric tube insertion** guideline
- Discuss procedure with parents/carer
- Wash hands and prepare equipment
- Bring milk to room temperature by removing from fridge and warming in a waterless warmer or in hot water. Never deliver fridge-cold milk directly via nasogastric or orogastric tube (see **Nutrition and enteral feeding** guideline)

Position of baby for feeding

- Baby need not be lying down. It is preferable to feed baby whilst receiving kangaroo care
- An awake and stable baby can be held for tube feed
- preferably skin-to-skin with parents holding baby in an upright position
- baby can also be placed in elevated side lying feeding position (ESLP) if skin-to-skin not possible at time of feed
- If lying flat in a cot elevate mattress to 30° before feeding and return to flat position within 1 hr

Checking pH

- Check pH of aspirate before **every** feed/use of tube according to NPSA guidelines (see **Nasogastric tube insertion** guideline)
- if pH 0– 5.5, commence feed and document pH
- if pH 5.0–5.5 confirm pH interpretation with a second person before commencing feed – if confirmed under 5.5 commence feed [with caution?]
- if pH ≥6, **do not** commence feed. Repeat aspiration and retest
- If repeated test ≥6, seek advice from senior clinician and undertake risk assessment following NPSA algorithm (see **Nasogastric tube insertion** guideline). Document decision made and rationale
- If no aspirate obtained, **do not** feed. Follow procedure outlined in NPSA guideline

Feeding

- Avoid rigid feeding patterns (e.g. 1 bottle/2 tube, alternate bottle/tube etc.) (see **Bottle feeding** guideline)
- When handling tubes, ensure clean technique. Pay careful attention to feed preparation and administration
- Administer feed by gravity
- Remove plunger, connect to tube, pour small volume of feed into barrel, raise level of barrel above baby's stomach. Control speed of administration by raising or lowering barrel
- Do not plunge feed
- Ensure tube feed takes approximately the same time as a suckling feed e.g.:
- 20 min for 3-hrly full feed volume requirement
- 10 min for 50% volume
- 5 min for 25% volume

Monitoring

- Observe baby throughout feed for signs of deterioration or distress (change in colour, cyanosis, apnoea, bradycardia, vomiting, straining, squirming, grimacing and other avoidance behaviour)
- Observe for abdominal distension following a feed

NASOGASTRIC TUBE ADMINISTRATION OF FEED, FLUID OR MEDICATION● 2/2

- If appropriate developmental stage/capabilities, offer small drops of milk to mouth to taste, but **avoid in babies with no swallow mechanism**
- Consider offering baby mother's breast for nuzzling or non-nutritive sucking during tube feed [see **Non-nutritive sucking (NNS)** guideline]
- On completion of feed, instil small amount of air into tube (0.5–1 mL)

DOCUMENTATION

- Document feed details:
  - pH of aspirate
  - type of feed
  - volume of feed
  - time of feed
  - behaviour/response during feed
  - adverse reactions (vomiting etc.)
- Ensure feed chart is signed

FURTHER MANAGEMENT

- For administration of medication, remember to check baby identity and prescription. Follow Trust policy for administration of medicines and British Association of Parenteral and Enteral Nutrition (BAPEN) guidance
  - document administration of medication on prescription chart
- Flushing of NGT is not routine in preterm babies. To avoid medication remaining in NGT try to give medications pre-feed. Where this is not possible 1 mL of feed can be used to flush tube after inserting medication

FURTHER INFORMATION

- **Nasogastric tube insertion** guideline

NASOGASTRIC TUBE INSERTION ● 1/4

Procedure is the same for both nasogastric and orogastric tubes. As nasogastric tubes (NGT) are more commonly used in babies, the term nasogastric will be used throughout this guideline

INDICATIONS

- To keep stomach deflated or to instil enteral feeds when full oral feeding not possible
- Administration of medications when unable to use oral route
- Orogastric tubes are used predominantly in babies in respiratory distress or with structural abnormality of nasal cavity where full bottle feeds are contraindicated
- NGT are used short-term for all other babies until full oral feeding achievable
- An NGT is preferred to an orogastric tube with a few exceptions, such as a structural abnormality (e.g. choanal atresia, cleft lip and palate) and some respiratory distress. It may still be possible to use an NGT if baby receiving nasal mask CPAP, or nasal prong oxygen

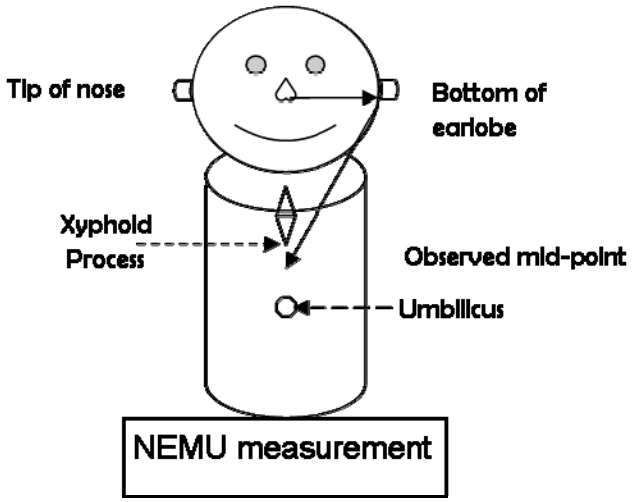
EQUIPMENT

- Smallest sized NPSA compliant NGT that will pass: 4 FG, 5 FG or 6 FG to reduce risk of nasal abrasions and ensure baby comfort
- Exceptions – surgical patient in specific clinical circumstances
- Enteral syringe
- pH testing strips (CE marked for use with human gastric aspirate)
- Extra-thin hydrocolloid dressing (e.g. Duoderm®, Convatec)
- Soft adhesive tape (e.g. Hypafix®, Tegaderm™, Mefix®)
- Non-sterile disposable gloves

PROCEDURE

Preparation

- Discuss procedure with parents/carer
- To prevent risk of aspiration, pass NGT before a feed
- Wash hands and prepare equipment
- Administer sucrose (see **Pain assessment and management** guideline)
- To reduce risk of epidermal stripping, apply Duoderm® to skin of face as an attachment for adhesive tape
- Determine length of tube to be inserted by measuring nose>ear>mid-umbilicus (NEMU) measurement. Note the cm mark on the tube or keep your fingers on the point measured



- For orogastric tube, measure as NGT but start from the centre of the bottom lip rather than the nose

Insertion

- With clean hands, put on gloves and pass tube into nose or mouth slowly and steadily until required pre-measured depth reached
- Use of a dummy (with parental permission) may help tube passage
- Observe baby throughout procedure for colour change, vomiting, respiratory distress or resistance
- if any of these features or distress occurs, stop and remove tube and try a different angle or nostril. If resistance felt, abandon procedure – **do NOT force the tube**

Checking position of nasogastric feeding tube

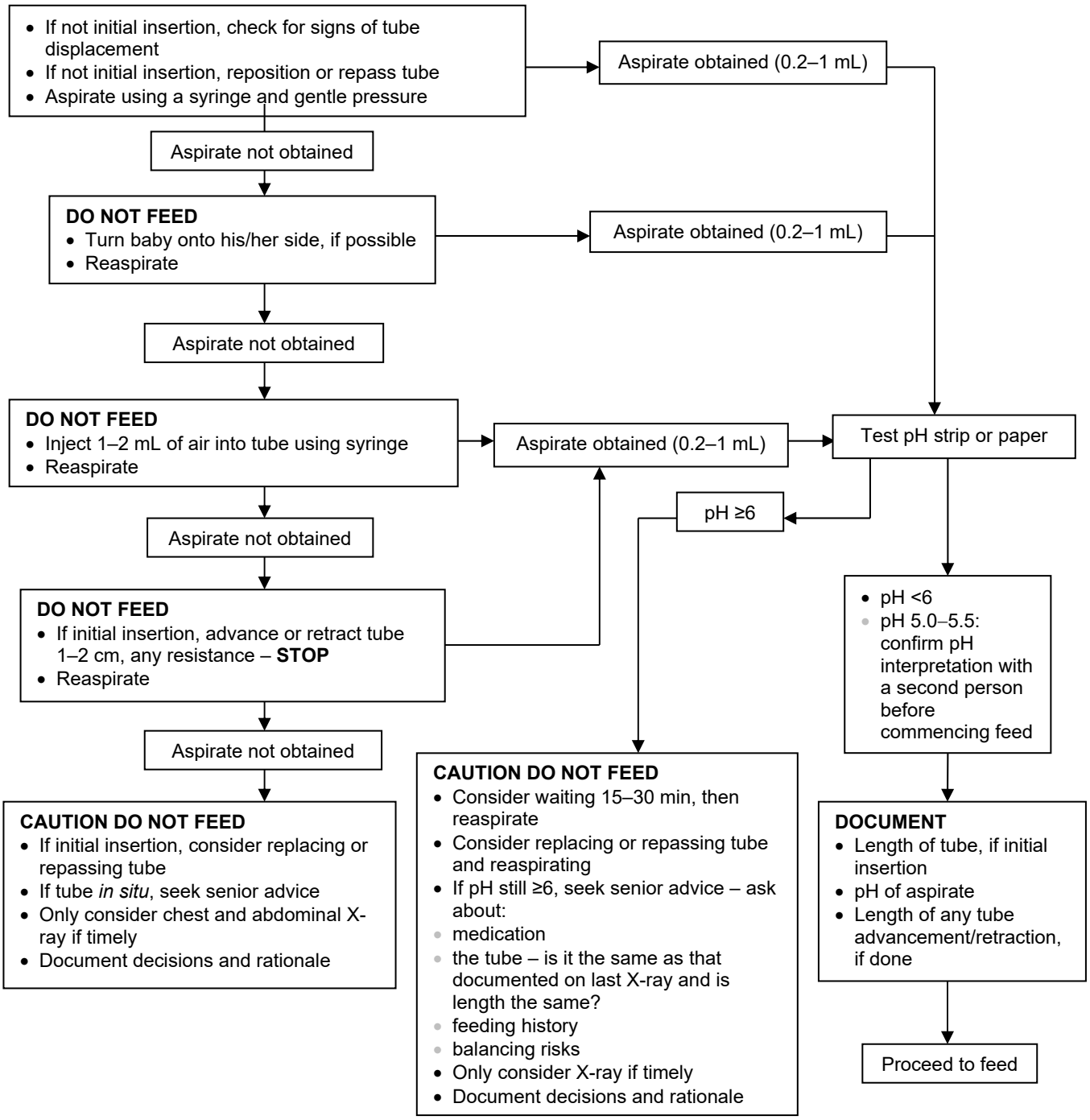
- NNUs and carers in the community should use pH indicator strips or paper
- Do **not** use radiography 'routinely' but, if baby being X-rayed for another reason, use X-ray to confirm position is satisfactory by noting position of tube on film
- Do **not** use 'Whoosh test' (auscultation of injected air entering the stomach) to determine position of NGT as it is unreliable

Checking position using pH

Never risk assess a newly placed NGT, if unable to aspirate a pH <5.5 X-ray

- Aspirate stomach contents with enteral syringe and test for acid response using the pH testing strips colour chart on container
- pH ≤5.5 indicates correct gastric placement. If pH 5 or 5.5, confirm pH interpretation with a second person before commencing feed
- if pH ≥6, **do not** commence feed. Repeat aspiration and retest
- if repeated test ≥6, seek advice from senior clinician and undertake risk assessment
- Following factors can contribute to high gastric pH ≥6
- presence of amniotic fluid in baby <48 hr
- milk in baby's stomach, particularly if 1–2 hrly feeds
- use of medication to reduce stomach acid
- tube positioned in jejunum or duodenum
- tube positioned in lungs
- Multidisciplinary care team to then discuss possible actions, balancing risk of feeding (with possibility of tube being in the lungs) and not feeding baby in the short-term, and record how decision reached
- Ensure you work through **NPSA flowchart** and record findings before making any decisions

NPSA flowchart: A basis for decision-making when checking position of naso- and orogastric feeding tube in babies on NNU


If not initial insertion, check for signs of tube displacement
If not initial insertion, reposition or repass tube
Aspirate using a syringe and gentle pressure
Aspirate obtained (0.2–1 mL)
Aspirate not obtained
DO NOT FEED
Turn baby onto his/her side, if possible
Reaspirate
Aspirate obtained (0.2–1 mL)
Aspirate not obtained
DO NOT FEED
Inject 1–2 mL of air into tube using syringe
Reaspirate
Aspirate obtained (0.2–1 mL)
Test pH strip or paper
pH ≥6
Aspirate not obtained
DO NOT FEED
If initial insertion, advance or retract tube 1–2 cm, any resistance – STOP
Reaspirate
pH <6
pH 5.0–5.5: confirm pH interpretation with a second person before commencing feed
Aspirate not obtained
CAUTION DO NOT FEED
If initial insertion, consider replacing or repassing tube
If tube in situ, seek senior advice
Only consider chest and abdominal X-ray if timely
Document decisions and rationale
CAUTION DO NOT FEED
Consider waiting 15–30 min, then reaspirate
Consider replacing or repassing tube and reaspirating
If pH still ≥6, seek senior advice – ask about:
medication
the tube – is it the same as that documented on last X-ray and is length the same?
feeding history
balancing risks
Only consider X-ray if timely
Document decisions and rationale
DOCUMENT
Length of tube, if initial insertion
pH of aspirate
Length of any tube advancement/retraction, if done
Proceed to feed

Securing tube

- Once correct tube position ascertained, secure to face with soft adhesive tape (e.g. Hypafix® or Mefix®) over Duoderm®

DOCUMENTATION

- Record procedure in medical notes, noting type and size of tube, NEMU, length inserted to, position, pH, date inserted and due for changing

FURTHER MANAGEMENT

Monitoring

- Check integrity of skin around nostril at frequent intervals for signs of deterioration
  - if signs of pressure appear, reposition tube and/or tape, or repass NGT via opposite nostril, or use orogastric route if necessary

- Check NGT position by measuring pH of aspirate. Follow **NPSA flowchart**:
  - after initial insertion and subsequent reinsertions
  - before administering each feed
  - before giving medication
  - after vomiting, retching or coughing (absence of coughing does not rule out misplacement or migration)
  - if evidence of tube displacement (e.g. if tape loose or visible tube appears longer or kinked)
  - when chest X-ray taken for another reason
- If receiving continuous feeds, use appropriate giving set and check pH when changing set
  - when continuous feeding has stopped, wait 15–30 min to allow stomach to empty of milk and for aspirate pH to fall

Changing NGT

- Follow manufacturer's recommendations
- Ensure safe and gentle removal of tape using water, applied with cotton bud to soften adhesive tape. **Never be tempted to rip tape directly from the skin**
- Pass new NGT via opposite nostril wherever possible
- Document removal/replacement in baby's medical record

Reporting misplaced tube incidents

- Report all misplaced feeding tube incidents using local risk management procedure

FURTHER INFORMATION

- Further details on determining correct position of oro-/nasogastric tubes in babies available from https://www.england.nhs.uk/wp-content/uploads/2016/07/Resource_set_-_Initial_placement_checks_for_NG_tubes_1.pdf

NECROTISING ENTEROCOLITIS (NEC) ● 1/3

RECOGNITION AND ASSESSMENT

Definition

Acute inflammatory disease in newborn intestine characterised by haemorrhagic necrosis, which may lead to perforation and destruction of the gut. Clinical presentation usually comprises triad of abdominal distension, gastrointestinal bleeding and pneumatosis intestinalis (air in bowel wall on abdominal X-ray)

Modified Bell's criteria

Stage 1: Suspected NEC – clinical signs suggestive but X-ray non-diagnostic

- Systemic signs:
  - temperature instability
  - apnoea
  - bradycardia
  - lethargy
- Intestinal signs:
  - increased gastric residuals
  - abdominal distension
  - vomiting
  - blood in stools
- Radiological signs:
  - normal/mild intestinal dilatation
  - thickened bowel loops

Stage 2: Definite NEC – mild-to-moderately ill, abdominal X-ray demonstrates pneumatosis intestinalis and/or gas in biliary tract

- Systemic signs: see **Stage 1** +/- mild metabolic acidosis, mild thrombocytopenia, raised CRP
- Intestinal signs: see **Stage 1** + absent bowel sounds, +/- localised abdominal tenderness, abdominal cellulitis or right lower quadrant mass, bright red blood and/or mucus from rectum (exclude local pathology)
- Radiological signs: significant intestinal dilatation, pneumatosis intestinalis, portal vein gas, +/- ascites, persistently abnormal gas pattern (e.g. localised dilated loop of bowel seen on serial X-rays or gasless abdomen)

Stage 3: Advanced NEC – severely ill, bowel intact or perforated

- Systemic signs: see **Stage 2** + hypotension, bradycardia, severe apnoea, combined respiratory and metabolic acidosis, DIC, neutropenia
- Intestinal signs: see **Stage 2** + signs of generalised peritonitis, marked tenderness, distension of abdomen
- Radiological signs: see **Stage 2** + pneumoperitoneum +/- ascites

Risk factors

- Prematurity
- Intrauterine growth restriction
- Absent or reversed end-diastolic flow on umbilical arterial Doppler antenatally
- Perinatal asphyxia
- Low systemic blood flow during neonatal period (including duct-dependent congenital heart disease)
- Significant patent ductus arteriosus
- Exchange transfusion
- Formula milk
- No antenatal corticosteroids
- Infections with: *Klebsiella, Enterobacter*, anaerobes

Differential diagnosis

- Sepsis with ileus
- Bowel obstruction
- Volvulus
- Malrotation
- Spontaneous intestinal perforation:
  - associated with early postnatal corticosteroids or indomethacin

- abdominal X-ray demonstrates pneumoperitoneum but does not show evidence of pneumatosis intestinalis
- Systemic candidiasis:
- clinical signs can mimic NEC with abdominal distension, metabolic disturbances, hypotension and thrombocytopenia
- Food protein-induced enterocolitis syndrome (FPIES)
- usually preceded by thrombocytosis in association with formula milk
- take thorough feeding history, and establish any temporal relationships with type of feed

INVESTIGATIONS

Abdominal X-ray

- Supine antero-posterior view
- If perforation suspected but not clear on supine view, left lateral view

Not all babies will have radiological findings associated with NEC (Stage 1)

Blood tests

- FBC: anaemia, neutropenia and thrombocytopenia often present; early return to normal carries good prognosis
- Blood film: evidence of haemolysis and toxic changes (e.g. spherocytes, vacuolation and toxic granulation of neutrophils, cell fragments, polychromatic cells)
- CRP, but a normal value not informative in initial phase
- U&E
- Blood gas: evidence of metabolic acidosis (base deficit worse than -10), raised lactate
- Coagulation screen
- Blood cultures

IMMEDIATE TREATMENT

Always discuss management with neonatal consultant

In all stages

- Nil-by-mouth
- If indicated, consider uplift/transfer to NICU/surgical centre. Nurse in incubator
- If respiratory failure and worsening acidosis, intubate and ventilate
- Gastric decompression
- Free drainage with large NGT (size 8)
- NEC often associated with significant third space fluid loss into peritoneum
- Triple antibiotics: flucloxacillin, gentamicin and metronidazole
- IV fluids/PN: total volume ≤150 mL/kg
- Long line when stable and bacteraemia/septicaemia excluded
- Pain relief, consider morphine/diamorphine infusion (see **Pain assessment and management** guideline)

Stage 2: Proven NEC (confirmed radiologically)

- If breathing supported by nasal CPAP, elective intubation to provide bowel decompression (see **Intubation** guideline)
- Give IV fluid resuscitation with sodium chloride 0.9% 10 mL/kg for shock and repeat as necessary. Shock is most common cause of hypotension in babies with NEC (see **Hypotension** guideline)
- If coagulation abnormal, give FFP (see **Coagulopathy** guideline)
- If thrombocytopenia and/or anaemia occur, transfuse (see **Thrombocytopenia** guideline)
- Discuss with surgical team: may need transfer to surgical centre

Stage 3: Advanced NEC (fulminant NEC with/without intestinal perforation)

- Treat as for **Stage 2** and refer to surgical team: may need laparotomy or resection of bowel in surgical centre
- See https://kids.bwc.nhs.uk/wp-content/uploads/2021/11/Damage-Control-Surgery-Flowchart-v1.0-Final.pdf

SUBSEQUENT MANAGEMENT

In recovery phase

- In **Stage 1**: if improvement after 48 hr, consider restarting feeds slowly (see **Nutrition and enteral feeding** guideline) and stopping antibiotics
- Take into account type of milk in the context of baby's feeding history before episode
- In **Stage 2**: if abdominal examination normal after 7–10 days, consider restarting feeds
- some may need longer period of total gut rest
- stop antibiotics after 7–10 days
- In **Stage 3**: discuss with surgeon and dietitian before restarting feeds

Late complications

- Recurrence (in about 10%)
- Strictures (in about 10% non-surgical cases)
- Short bowel syndrome and problems related to gut resection
- Neurodevelopmental delay

MONITORING TREATMENT

- Observe general condition closely and review at least 12-hrly
- Daily:
- acid-base status
- fluid balance (twice daily if condition unstable)
- electrolytes (twice daily if condition unstable)
- FBC and coagulation (twice daily if condition unstable)
- repeat X-ray daily or twice daily until condition stable. Discuss with consultant/surgeon

LONG-TERM MANAGEMENT

- Advise parents about signs of bowel obstruction
- Medical +/- surgical follow-up after discharge
- Contrast studies if clinically indicated for strictures
- Appropriate developmental follow-up

PARENT INFORMATION

Offer parents information on NEC, available from https://www.bliss.org.uk/parents/about-your-baby/medical-conditions/necrotising-enterocolitis-nec-a-guide-for-parents

NITRIC OXIDE ● 1/2

INDICATIONS

- Persistent pulmonary hypertension of the newborn in term and near term (>34 weeks) babies, proven on clinical grounds or by echocardiography (see **Pulmonary hypertension** guideline)
- Oxygen index >20
- Pre and post ductal SpO_2 difference >10%
- Babies requiring NO should be referred to a NICU for ongoing management, in accordance with Neonatal Critical Care Service Specification 2024
- Initiate treatment with nitric oxide (NO) only in a NICU or with transport team at cotside, after discussion with consultant

CAUTIONS

- Preterm baby
- no evidence of benefit for preterm babies needing ventilation for RDS and some evidence of harm
- may be some survival benefit for preterm babies with history of oligohydramnios, premature rupture of membranes and/or pulmonary hypoplasia and PPHN – discuss with consultant
- Platelets $<50 \times 10^9$/L
- Known or suspected major haemorrhage
- Congenital diaphragmatic hernia
- Severe methaemoglobinemia

CONTRAINDICATIONS

- Congenital heart disease (especially circulations dependent on right-to-left shunting)

DOSE AND ADMINISTRATION

Starting NO

Preparation

- Ensure ventilation optimal and that other aspects of the **Pulmonary hypertension** guideline have been followed
- Echocardiogram (if available) to exclude cyanotic congenital heart disease
- A sustained inflation immediately before starting NO can enhance response
- If not previously administered, discuss dose of surfactant before commencement of NO with consultant

Administration

- Document FiO_2 and SpO_2 immediately before starting NO
- Start NO at 20 ppm
- NO displaces oxygen so expect inspired oxygen displayed on INOvent to read lower than that on ventilator. Ensure consistency of documentation on charts
- Assess response after 30–60 min. If no response (see below) stop NO
- NO can be stopped abruptly without weaning if given for <4 hr

Definition of response to NO

- An increase in SpO_2 or PaO_2 whilst on the same ventilator settings or an ability to wean FiO_2 whilst maintaining SpO_2 occurring within 60 min of starting NO
- Approximately 30% of babies with PPHN do not respond to NO

Table 1: Definition of a response to NO

Response	Increase in SpO_2	Increase in PaO_2	Fall in FiO_2
Full	>20%	>3 kPa	>0.2
Partial	10–20%	2–3 kPa	≥0.1

Weaning

- If no response to NO after 60 min stop NO without weaning
- If NO has been administered for ≥4 hr, wean gradually to prevent rebound (as below)
- If full or partial response to NO when preductal SpO_2 can be maintained in target range with FiO_2 <0.6 and after at least 4 hr treatment weaning can be attempted
- reduce NO to 10 ppm
- in 1–2 hr reduce NO to 5 ppm
- in 1–2 hr reduce NO to 4 ppm and continue to reduce NO by 1 ppm every 1–2 hr
- after 1–2 hr at 1 ppm increase FiO_2 by 0.1–0.2 10 min before stopping NO

- some babies will require low dose (<0.5 ppm) for some time (up to 24 hr) during weaning
  - may be necessary to temporarily increase FiO_2 by 0.1–0.2 to facilitate weaning
- Failure of weaning is defined as either
- >5% reduction in SpO_2 or
- need to increase FiO_2 by >0.2 to maintain SpO_2 or
- development of >10% difference between pre- and postductal SpO_2
- If weaning fails at any stage increase NO to previous dose and wait ≥4 hr before trying again
- Once discontinued, wait ≥6 hr before removing NO circuit from ventilator

MONITORING

- Use SpO_2 to monitor response
- Blood gases 4-hrly
- Monitor methaemoglobin before starting NO, 1 hr after starting and then 12-hrly. Maximum proportion of total haemoglobin is reached after 8 hr
- normal <1%
- 2–3% is acceptable
- 4% requires action: reduce NO and repeat in 1 hr
  - if still >4%, stop NO
  - if >6%, treat with methylthioninium chloride (methylene blue) 1 mg/kg IV over 1 hr
- Check FBC daily while baby receiving NO. NO inhibits platelet function and can trigger bleeding if baby has bleeding problem or thrombocytopenia.
- Monitor. If >1 ppm reduce NO dose

NON-NUTRITIVE SUCKING (NNS) ● 1/1

DEFINITION

- Includes:
- sucking of fingers
- use of appropriately sized dummies with/without sucrose

INDICATIONS

- Actively promoted for:
- comfort
- pain relief
- maximising nasal CPAP delivery. Can be used for short period to assist in acquisition of an effective seal
- developing the sucking reflex and assisting transition from tube to full breast or bottle feeding
- normal peristalsis helping to alleviate gastro-oesophageal reflux
- Encourages preterm babies not mature enough to suck at feed times to suck on a non-nutritive device during a tube feed
- Form of non-pharmacological pain relief during painful procedures
- use expressed breast milk (EBM) for dummy dips (consider condition of baby)
- if no EBM available, use sucrose
- Decreases:
- stress
- risk of SIDS (with appropriate sleeping positions)

CAUTIONS

- As baby begins to take more enteral feeds (at around 33 weeks), NNS no longer appropriate as may mask feeding cues

CONSENT

- Before commencing, ensure parents receive written information on suitable use of NNS on NNU
- A signed informed consent form must be held in baby's medical record

NUTRITION AND ENTERAL FEEDING ● 1/9

PRINCIPLES

- Maternal breast milk (MBM) is the optimal feed for all babies. Mothers should be counselled and supported to express milk as soon as possible after birth and frequently thereafter to ensure adequate supply for baby
- Compared to formula milk maternal colostrum and breast milk reduce rates of mortality, BPD and ROP, reduce risks of NEC and sepsis and improves neurodevelopmental outcomes
- Early enteral feeds promote normal gastrointestinal structure and function, motility and enzymatic activity
- Delayed nutrition can result in growth restriction with long-term complications of parenteral nutrition, dysbiosis of the intestine, poor organ growth and poorer neurological outcomes
- Manage feeding on an individual basis dependent upon gastrointestinal tolerance and availability of maternal breast milk
- This guideline is designed to be used in conjunction with individual clinical assessment processes

NUTRITIONAL REQUIREMENTS

Table 1: Daily recommended intake of nutrients for stable growing term and preterm babies

Nutrient	Term baby	Preterm baby (ESPGHAN 2022)
Energy (kcal/kg/day)	95–115	115–140 (160*)
Protein (g/kg/day)	2	3.5–4.0 (4.5*)
Sodium (mmol/kg/day)	1.5	3.0–5.0 (8.0*)
Potassium (mmol/kg/day)	3.4	2.3−4.6
Calcium (mmol/kg/day)	3.8	3.0−5.0
Phosphorus (mmol/kg/day)	2.1	2.2−3.7
Zinc(mg/kg/day)	4.0 (mg/day)	2.0−3.0
Iron (mg/kg/day)	1.7 (mg/day)	2.0−3.0 (6.0*)
Folic acid (µg /kg/day)	50 (µg /day)	23−100
Vitamin A (µg RE/kg/day)	59	400–1000
Vitamin D (units/kg/day)	400	400−700 (<1000*)

***upper intakes that may occasionally be required in routine clinical practice under certain conditions – seek advice from neonatal dietitian**

FEEDING GUIDE

- Commence enteral feeds in preterm and sick babies as close to birth as possible (unless clinically contraindicated)

Buccal colostrum

- Provides benefits of colostrum to **all** sick and premature babies unable to breast feed orally
- Give to **all** babies admitted to NNU who are not receiving oral feeds unless maternal breast milk is contraindicated (see **Breastfeeding** guideline)
- Place 0.3 mL (0.15 mL per side) colostrum in buccal cavity by syringe/gloved finger at 3-hrly intervals for first 48 hr of life
- Parental involvement in administration recommended. Nursing staff may teach and supervise parents to give colostrum

ENTERAL FEEDS

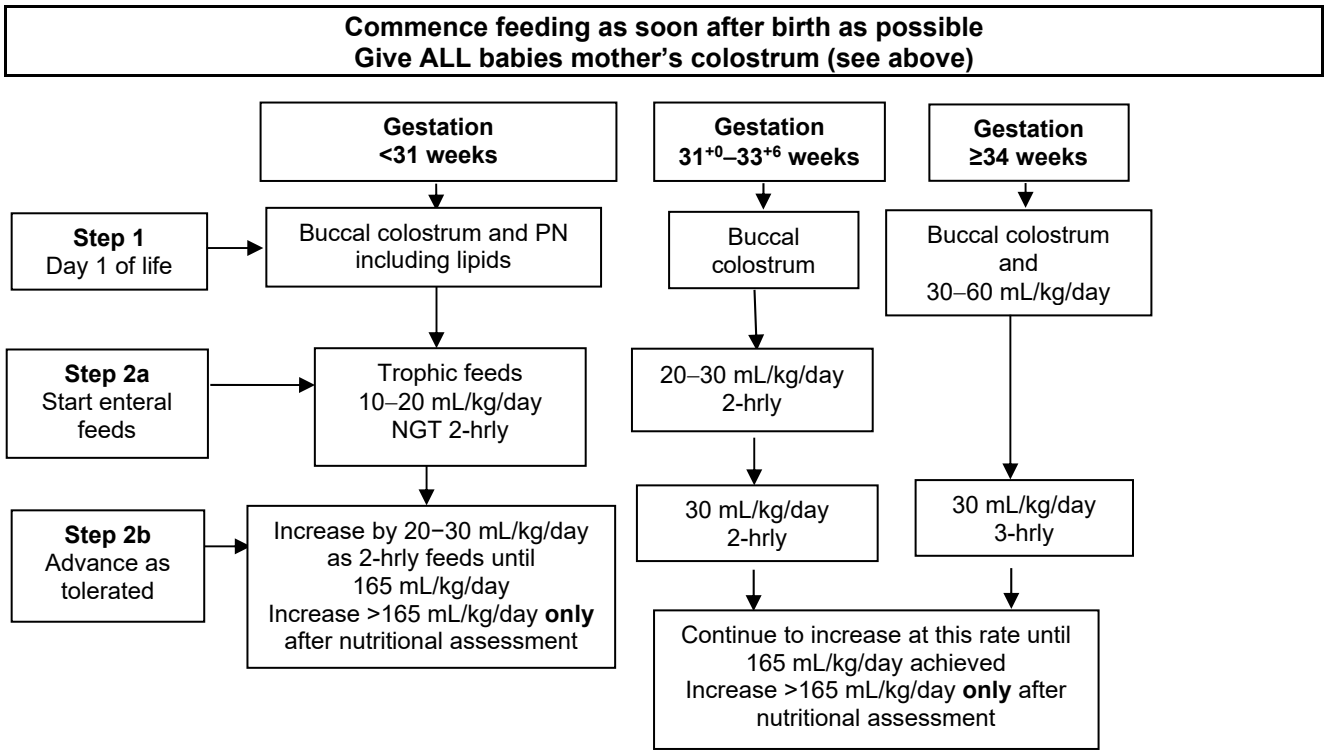
Route of administration

- Most babies <34 weeks are unable to co-ordinate sucking, swallowing and breathing to feed effectively and so should be fed via a naso- or orogastric tube
- Some babies <34 weeks may show feeding cues, especially while in skin-to-skin. They may be offered the breast, but bottle feeds should not be offered until >34 weeks (see **Progression to suck feeding in preterm babies** guideline)

Initiating and advancing enteral feeds

- Make every effort to use mother's fresh expressed colostrum and breast milk

Flowchart 1: Initiating and advancing feeds


Commence feeding as soon after birth as possible
Give ALL babies mother's colostrum (see above)
Gestation <31 weeks
Gestation 31+0–33+6 weeks
Gestation ≥34 weeks
Step 1
Day 1 of life
Buccal colostrum and PN including lipids
Buccal colostrum
Buccal colostrum and 30–60 mL/kg/day
Step 2a
Start enteral feeds
Trophic feeds 10–20 mL/kg/day NGT 2-hrly
20–30 mL/kg/day 2-hrly
Step 2b
Advance as tolerated
Increase by 20–30 mL/kg/day as 2-hrly feeds until 165 mL/kg/day
Increase >165 mL/kg/day only after nutritional assessment
30 mL/kg/day 2-hrly
30 mL/kg/day 3-hrly
Continue to increase at this rate until 165 mL/kg/day achieved
Increase >165 mL/kg/day only after nutritional assessment

- If maternal breast milk (MBM) not available within 48 hr of birth, use donor breast milk (DBM), if criteria met, or preterm formula
- If unable to advance enteral feeds in first 3−7days:
  - maintain trophic feeds small volumes (10–20 mL/kg/day) intended to stimulate gut trophic hormones
  - contact neonatal dietitian
  - In babies >31^{+0} review need for parenteral nutrition (see **Parenteral nutrition** guideline)

PROBIOTICS

- Reduce rates of NEC, sepsis, and mortality in preterm babies
- See **WMPN Guidance on Probiotics in the NNU** https://www.teamwmcn.nhs.uk/download/docm93jijm4n21391.pdf?ver=34484
- All babies born <32 weeks' gestation or any preterm baby with a birth weight 1.5 kg to receive probiotics in first 24 hr of life unless contraindicated
- Provide parents with written information on potential benefits and risks of probiotic administration
- Insufficient evidence currently to recommend one product over another
- Administer probiotics via NG/OGT tube or orally when established on oral feeds
- Flush O/NGT with 0.5–1 mL colostrum/MBM/DHM after administering probiotics
- Suspend probiotics if enteral feeds are stopped for:
  - conservative management of NEC or GI surgery and restart probiotics when the baby is receiving minimum of 50 mL/kg/day enteral feeds
  - any other reason, restart probiotics when baby receiving 20 mL/kg/day enteral feeds
- Stop probiotics at 34 weeks' gestation/discharge, whichever is soonest

WHICH MILK TO USE

Maternal breast milk (MBM)

- Remains the ideal milk for term and preterm babies
- Support mothers to initiate and maintain expressing (see **Breastfeeding** guideline)
- Wherever possible, use MBM for initiation of enteral feeds. If milk supply insufficient for requirements it may not always be possible to follow feeding schedules until sufficient breast milk is available
  - record absence of MBM as 'no maternal milk available' (NMMA)
  - if insufficient MBM at 48 hr of life to meet requirements, give all available MBM and use appropriate alternative milks to commence or advance feeds

Donor breast milk (DBM)

- DBM should be offered to all babies <32 weeks or <1500 g to establish enteral feeds when MBM is unavailable or insufficient to meet baby's requirements
- DBM may also be offered for the short-term support of any baby on NNU whose mother is seeking to establish breast milk supply
- Essential to add breast milk fortifier (BMF) to DBM to meet nutrient requirements for preterm babies when volume intakes reach 100 mL/kg/day, then advance to 165 mL/kg/day as tolerated
- DBM use is generally restricted to establishing enteral feeds only
- Fortified DBM use can be prolonged for ELBW babies (<1000 g) where there is continued shortfall in MBM, with close monitoring of all growth parameters. Introducing alternative feeds when baby reaches 1000 g or shows suboptimal growth
- Once full volumes achieved (165 mL/kg/day) and baby aged ≥14 days introduce suitable alternative feed based on nutritional requirements (see **Slow change to a different type of milk feed**)
- Consent for DBM use must be obtained from parents

Breast milk fortifier

- Required by **all** babies born <34 weeks and/or <1.8 kg fed exclusively on M/DBM to meet protein and micronutrient requirements for growth
- Add BMF when M/DBM volumes reach 100 mL/kg/day
- Increase volume of M/DBM + BMF to maintenance full feeds of 165 mL/kg/day
- Use at full strength in M/DBM
- BMF use should continue until term age

Table 2

Nutriprem HMF	1 sachet HMF added to 25 mL M/DBM
SMA BMF	1 sachet BMF added to 25 mL M/DBM

- Prepare as per manufacturer's instructions:
  - add BMF as close to feed time as possible
  - **swirl** breast milk gently to dissolve BMF to protect fragile cellular components in breast milk
- Feed **immediately** or store in fridge until required and use within 12 hr of preparation
- If baby receiving >50% requirements as preterm formula, stop BMF – unless advised to continue by neonatal dietitian

Table 3: Composition of mother's own breast milk, and fortified breast milk/100 mL

	Mature breast milk (>2 wk)	Fortified mature breast milk (Nutriprem HMF) (2021 data card)	Fortified mature breast milk (SMA PRO BMF) (2020 data card)
Energy (kcal)	69	86	86.2
Protein (g)	1.3	2.6	2.74
CHO(g)	7.2	8.7	8.5
Fat (g)	4.1	4.8	4.82
Sodium (mmol)	0.7	2.9	2.35
Calcium (mmol)	0.55	2.3	2.75
Phosphorus (mmol)	0.5	1.8	1.9
Vitamin A (µg)	57	289	438
Vitamin D (iU)	2	221	<160
Iron (mg)	0.07	0.07	1.87

- Use of BMF post discharge is recommended in babies:
  - discharged <term age and/or <1.8 kg
  - establishing oral breast feeding
  - showing slow growth velocity

- See for guidance on use of fortifier supplements for babies establishing oral feeds. All babies should be weaned off fortifier supplements by 6 weeks post-term (see docm93jijm4n21389.pdf)

Table 4: Preparation and administration of post discharge fortifier supplements

Fortifier supplements in breast fed babies <40 weeks		
Nutriprem HMF	2 sachets HMF added to 3 mL MEBM	Give immediately before a breast feed **4 times per day**
SMA BMF	2 sachets BMF added to 3 mL MEBM	Give immediately before a breast feed **4 times per day**

Protein supplement (Nutriprem protein supplement)

- Use only under direction of neonatal/paediatric dietitian
- Provides extra protein to meet requirements of babies <1000 g
- Indicated if energy and protein intake are below requirements
- Extensively hydrolysed protein alone − **NO** micronutrients or energy
- Add to M/DBM alongside BMF or direct to preterm formula
- 1 g sachet = 0.82 g protein
- If blood urea in normal range do not add protein supplement discuss with neonatal/paediatric dietitian
- Monitor blood urea twice weekly in all babies on protein supplement
- **Stop** protein supplement when urea level >6 or when baby reaches 1000 g

Preterm milk formula

- **Nutriprem 1/SMA Gold Prem 1**: formulated to meet the nutrient needs of preterm babies born <34 weeks or <1.8 kg where insufficient MBM to meet requirements
- **Nutriprem 2/SMA Gold Prem 2**: nutrient enriched post-discharge formula (NEPDF) formulated to meet the ongoing enhanced nutrient needs of babies born <34 weeks, once beyond term age
- Babies with normal growth velocity and no requirement for catch-up growth may be discharged on term formula with appropriate vitamin and mineral supplementation
- NEPDF especially useful for babies who have higher nutritional requirements (e.g. CLD on oxygen) or babies who have ongoing poor growth (e.g. have crossed down >2 centiles on growth chart during neonatal stay)
- Volumes >165 mL/kg are not usually necessary and other reasons for poor growth should be sought before further volume increases introduced (see **Inadequate growth**)

Specialised preterm formula (Hydrolysed Nutriprem 1)

- **Always** use under direction of neonatal/paediatric dietitian
- Hydrolysed Nutriprem 1 – extensively hydrolysed protein preterm formula
- may be suitable for babies who fail to tolerate/progress on standard preterm formula or have a family history of CMPI (**NOTE** contains lactose)

Table 5: Composition of preterm formula/100 mL

	Nutriprem 1 (2020 data card)	Hydrolysed Nutriprem 1 (2020 data card)	SMA Gold Prem 1 (2020 data card)
Recommended volumes mL/kg/day	150–180	150–180	150
Energy (kcal)	80	80	80
Protein (g)	2.7 (whole protein)	2.6 (partially hydrolysed)	2.9 (partially hydrolysed)
CHO (g)	8.4 (55% lactose)	8.4 (46% lactose)	8.1 (45% lactose)
Fat (g)	3.9 (8% MCT)	4 (7% MCT)	4 (12.5% MCT)
Sodium (mmol)	3	3.3	2.4
Calcium (mmol)	2.5	2.4	3.0
Phosphorus (mmol)	2.0	1.75	2.5
Vitamin A (µg RE)	366	366	330
Vitamin D (µg)	3.1	3.1	3.4

All 'specialised' term formulas

- **Do not** provide adequate nutrition for preterm babies at standard dilution so require modification to ensure nutritional requirements met. Use only when clinically indicated and always under direction of paediatric/neonatal dietitian

Table 6: Maintenance feeds for neonates based on gestational age and/or weight

Gestational age and/or weight	Maintenance feed
<32 weeks **and/or** <1000 g	• M/DBM + BMF: 165 mL/kg/day • Nutriprem 1: 165 mL/kg/day • SMA Gold Prem 1: 150 mL/kg/day
Born between or on reaching 32+[1]–33[+6] weeks	• MBM + BMF: 165 mL/kg/day • Nutriprem 1: 165 mL/kg/day • SMA Gold Prem 1: 150 mL/kg/day
On reaching 34 weeks	• MBM + BMF: 165 mL/kg/day • Nutriprem 1: 165 mL/kg/day • SMA Gold Prem 1: 150 mL/kg/day • Introduce oral feeds (see **Progression to suck feeding** guideline) • Introduce fortifier supplements as breastfeeding increases (see **Breast milk fortifier**)
Preterm babies (born <34 weeks) at discharge or term age (whichever is earliest)	**<36[+6] weeks** • **Breast milk feeding** ◦ modified responsive breast feeding with fortifier supplements (see BMF section) • Expressed MBM + BMF: 165 mL/kg/day • **Formula feeding:** ◦ **<1.8 kg:** − Nutriprem 1: 165 mL/kg/day − SMA Gold Prem 1: 150 mL/kg/day ◦ **≥1.8 kg:** − NEDPF: 165 mL/kg/day
	≥37 weeks • **Normal growth velocity and no requirement for catch-up growth:** ◦ allow natural reduction in BMF as breastfeeding increases, transition to responsive breastfeeding ◦ if insufficient MBM/parents choose to formula/mix feed use term formula • **Poor growth velocity and catch-up growth required:** ◦ **breast milk feeding** − modified responsive breast feeding with fortifier supplements (see BMF section) • **Expressed MBM + BMF: 165 mL/kg/day** ◦ **formula feeding** − NEDPF: 165 mL/kg/day
Born ≥34–37 weeks **and** <1.8 kg	• MEBM and BMF: 165−180 mL/kg/day ◦ modified responsive breastfeeding with fortifier supplements (see **Breast milk feeding** section) • NEPDF 165 mL/kg/day modified responsive bottle feeding (see **Bottle feeding in the neonatal unit** guideline)
Born ≥34 weeks and ≥1.8 kg	• Modified responsive breastfeeding or MEBM 180 mL/kg/day via NGT/OGT (see **Breastfeeding** guideline) • Term formula 165–180 mL/kg/day via NGT/OGT or modified responsive bottle feeding (see **Bottle feeding in the neonatal unit** guideline)

Change to different type of milk feed

- Done slowly to ensure baby tolerates change
- **Day 1**: 75% feeds with current milk, 25% with new milk (i.e. 3 old feeds:1 new feed)

- **Day 2**: 50% feeds with current milk, 50% with new milk (i.e. 2 old feeds:2 new feeds)
- **Day 3**: 75% feeds with new milk, 25% with current milk (i.e. 1 old feed:3 new feeds)
- **Day 4**: 100% new milk
- It is acceptable to mix the milks together

Do not add HMF/BMF to formula – omit during slow change if feeds being mixed

VITAMIN SUPPLEMENTATION

- Start enteral vitamin supplements when babies reach 100 mL/kg/day enteral feeds
- For babies transitioning from PN start enteral vitamins when on 10 mL/kg/day lipids
- Dose of vitamin supplement given in mixed feeding regimens to be informed by the predominant feed (i.e. feed which comprises >50% of intake)
- Continue vitamin doses until aged 6 months corrected age –at which point DoH guidance on childhood vitamin supplementation should be explained to parents Vitamins for children - NHS (www.nhs.uk)

Table 7

	Current weight	ABIDEC	
Babies born <34 weeks and/or <1.8 kg			
Fortified MEBM/DEBM **Preterm Formula (Nutriprem 1 or SMA Gold Prem 1)**	≤1 kg	0.3 mL once daily	
	>1 kg	0.6 mL once daily	
***Unfortified MBM/DBM**	≤1 kg	0.6 mL once daily **AND** Folic Acid 50 microgram daily	
	>1 kg	0.6 mL once daily **AND** Vitamin D 600 units **alternate days** **AND** Folic Acid 50microgram daily	
		Choose ONLY 1 multivitamin preparation	
		ABIDEC	**Healthy start vitamins**
Babies born <34 weeks' gestation when reaching ≥1.8 kg OR at discharge			
Post discharge formula (Nutriprem 2/SMA Gold 2) **MBM and post-discharge fortifier** **High energy infant formula (Infatrini/SMA high energy)**		0.3 mL once daily	3 drops once daily
Unfortified MBM **Term formula**		0.6 mL once daily	5 drops once daily
Babies born 34–37 weeks AND ≥1.8 kg			
Unfortified MBM **Term formula**		**0. 6 mL once daily**	**5 drops once daily**

*Preterm babies fed exclusively on unfortified breast milk will not meet recommended intakes for calcium/phosphate and other essential micronutrients. Additional supplements of Vitamin D (Colecalciferol) and folic acid will be needed alongside multivitamin preparations. Care needs to be taken to ensure risk of deficiency of micronutrients is minimised, especially the impact on metabolic bone disease see **Metabolic bone disease** guideline for advice on screening and supplementation

† **NOTE** doses of Abidec® and Dalivit ® are not equivalent due to differing levels of vitamin content, especially vitamin A. In the absence of ABIDEC consider using Healthy Start Vitamins as next best alternative and seek advice of neonatal dietitian/pharmacist (see **Table 8** below)

Table 8: Multivitamin supplements

	Abidec 0.6 mL	Dalivit 0.6 mL	Healthy start children's vitamin 5 drops
Vitamin A (units)	1333	5000	776
Vitamin D (units)	400	400	400
Vitamin C (mg)	40	50	20
Thiamine B1 (mg)	0.4	1	X
Riboflavin B2 (mg)	0.8	0.4	X
Pyridoxine B6 (mg)	0.8	0.5	X
Nicotinamide B3 (mg)	8	5	X

VITAMIN K

- Babies receiving fortified breast milk, preterm or term formula do not need supplementation at any time.
- Routine post discharge vitamin K supplementation not advised (limited clinical and published evidence of risks of subclinical vitamin K deficiency)
- Vitamin K supplementation to be given to 'at risk' babies only:
  - ALL cholestatic babies – see **Liver dysfunction** guideline for specific vitamin doses
  - babies born <34 weeks, receiving breast milk feeds only **at discharge**, who have received suboptimal fortifier intake during neonatal unit stay
  - prescribe 3 month supply, using one of two available vitamin K preparations:
    - NeoKay oral drops: 50 microgram (0.25 mL) once daily (NOTE: this is a food supplement and not technically a medicinal product **OR**
    - Konakion MM Paediatric amps 2 mg/0.2 mL: 2 mg oral **once monthly** (parents will require counselling at discharge on how to administer)
- Units to keep local records of all babies who receive post discharge vitamin K for audit purposes

Suboptimal fortifier

- **Defined** as fortifier withheld for >50% breast milk feeds during neonatal unit stay
- Seek advice from unit or paediatric dietitian to determine if baby meets criteria

IRON SUPPLEMENTATION

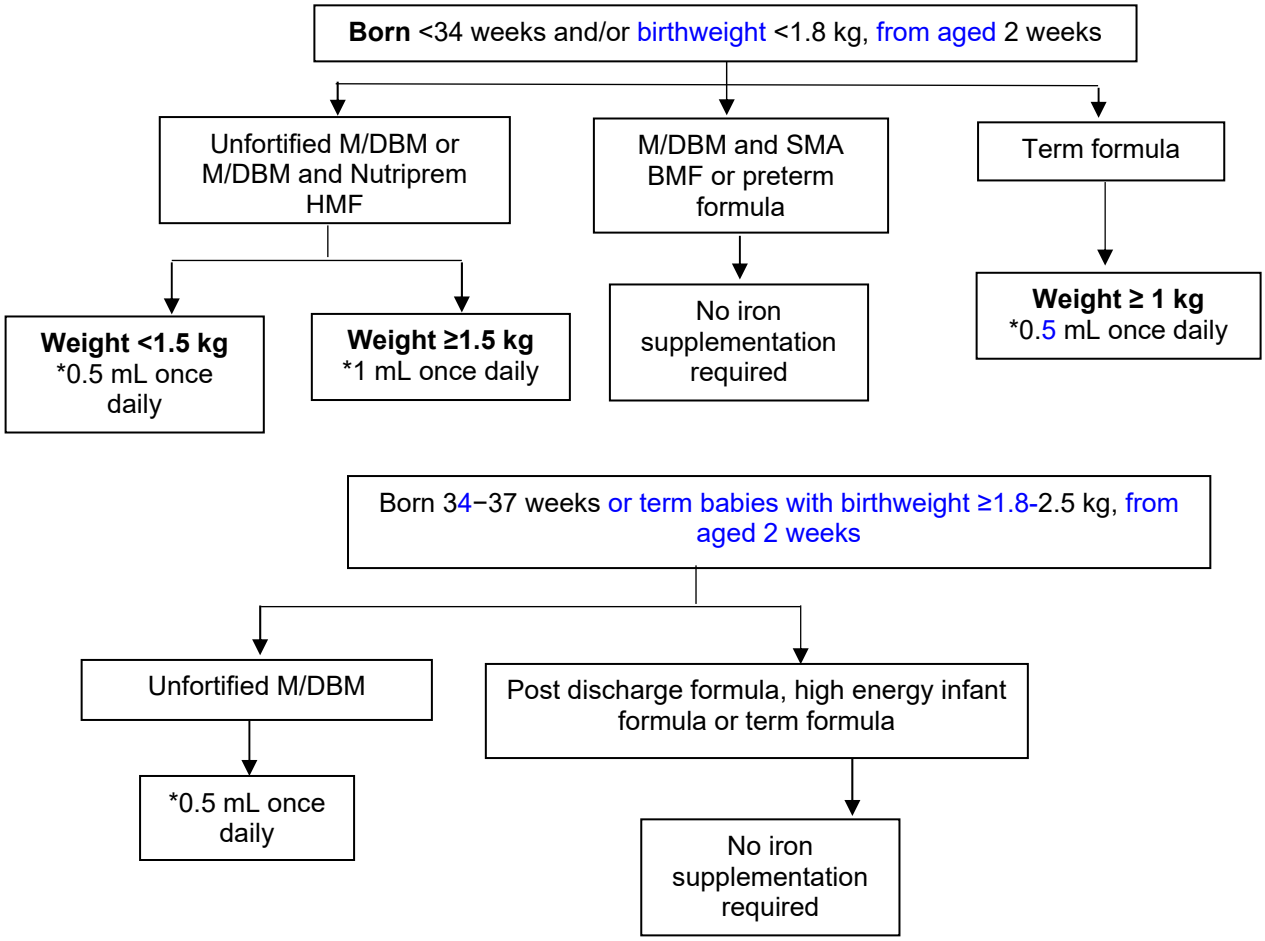
- Only required where milk feed does not contain enhanced iron levels to meet recommended intakes – see **Flowchart 2**
- Start iron supplementation from aged 2 weeks and tolerating 100 mL/kg/day enteral feeds
  - **note:** in babies **not** tolerating 100 mL/kg/day enteral feeds at aged 2 weeks discuss administration of iron supplements with neonatal dietitian or pharmacist
- Using *sodium feredetate (27.5 mg iron/5 mL)
- Dose of iron given in mixed feeding regimens to be informed by the predominant feed (i.e. feed which comprises >50% of intake)
- Recommended iron intakes − see **Table 10**

Table 9

Baby	Birth weight	Iron intake, AIM:
Preterm <34 weeks	<1.8 kg	2−3 mg/kg/day
≥34−<37 weeks	<2 kg	2−3 mg/kg/day
Term baby ≥37 weeks	2−2.5 kg	1−2 mg/kg/day

- Continue iron supplements until aged 12months actual age
- Monitor iron intake by regular measurements of Hb, serum ferritin and CRP

Flowchart 2: Iron supplementation to meet recommended intakes


Born <34 weeks and/or birthweight <1.8 kg, from aged 2 weeks
Unfortified M/DBM or M/DBM and Nutriprem HMF
M/DBM and SMA BMF or preterm formula
Term formula
Weight <1.5 kg *0.5 mL once daily
Weight ≥1.5 kg *1 mL once daily
No iron supplementation required
Weight ≥ 1 kg *0.5 mL once daily
Born 34−37 weeks or term babies with birthweight ≥1.8-2.5 kg, from aged 2 weeks
Unfortified M/DBM
Post discharge formula, high energy infant formula or term formula
*0.5 mL once daily
No iron supplementation required

FEED TOLERANCE EVALUATION

Monitoring of feed tolerance, growth and biochemical balance is critical in nutritional management of preterm babies to ensure optimal outcomes

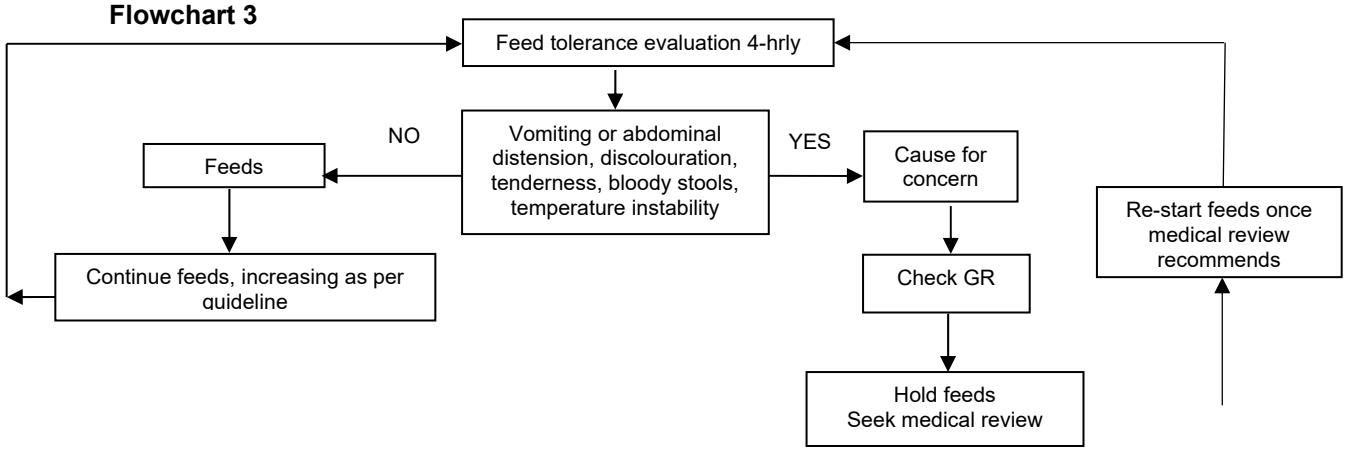
Feed tolerance

- Poor gut motility is common among VLBW/ELBW babies, and some will have episodes requiring temporary discontinuation of feeding or delay in advancing feeds
- If failure to progress feeds continues over several days, seek advice early from neonatal/paediatric dietitian

Assessment of gastric residuals (GR)

- Evaluate feed tolerance 4-hrly (see **Flowchart 3**)
- Routine aspiration of GR not recommended in preterm babies
- Do not use GR volumes in isolation when deciding to limit advancement of feeds

Flowchart 3



Anthropometry
- See **Growth monitoring** guideline

Biochemical monitoring
- Measure plasma urea, electrolytes, ALP, calcium, and phosphate weekly in stable preterm babies
- Monitor glucose closely in initial few days

INADEQUATE GROWTH VELOCITY
- Preterm babies with sub-optimal growth velocity require further assessment
- Review proportional growth (weight, head, length) on age and gender appropriate growth chart
- Ensure baby **prescribed** and **receiving** recommended nutritional intake. Ensure on maximum advised volume of age/weight appropriate feed – see maintenance feed volume/type charts
- Review energy and protein intake per kg/day against ESPGHAN recommendations for weight/gestational age
- Measure urine sodium concentration. Value <20 mmol/L indicates sodium depletion (not valid if baby on diuretics)
- If sodium supplements required:
  - check urine sodium weekly
  - keep **total enteral** sodium intake (feed + standard supplement + prescribed supplement) < 8 mmol/kg/day
- In babies receiving MBM use hind milk (see **Breast milk expression** guideline)
- Check zinc level in cases of poor growth associated low ALP, especially in surgical babies where excess GI losses are possible and supplement if low
- Refer to neonatal/paediatric dietitian for assessment and advice
- Do not advance feed volumes beyond that recommended unless on advice of dietitian
- **Formula fed >37 weeks, ≥2 kg:**
  - replace 25–50% MEBM/NEPDF with high energy term formula (Infatrini, SMA High Energy, Similac® High Energy) and refer to paediatric/neonatal dietitian for follow-up
- **Breast milk fed >37 weeks:**
  - stop BMF in MBM but continue with concentrated BMF supplements as detailed in **Breast milk fortifier** section

Note: Department of Health Guidelines state all children aged 6 months–5 yr receive vitamin supplementation containing vitamins A C D unless receiving formula milk >500 mL/day Exclusively breastfed babies should receive vitamin D supplementation from birth

OESOPHAGEAL ATRESIA ● 1/3

DEFINITION

Congenital anomaly with blind ending oesophagus which may be associated with a fistula between the abnormal oesophagus and the trachea

DIAGNOSIS

- Suspect antenatally if scans show polyhydramnios +/- absent stomach bubble
- refer to fetal medicine specialist
- plan appropriate place of delivery
- parents should meet paediatric surgeon antenatally
- Most cases present shortly after birth. Suspect if:
- history of polyhydramnios +/- absent stomach bubble
- frothing at mouth
- respiratory symptoms on feeding
- difficulty in passing nasogastric tube (NGT)
- anorectal malformation (see **Anorectal malformation** guideline)

DELIVERY

- If diagnosis suspected antenatally, avoid:
- any positive pressure ventilation [including mask ventilation, HFNC, CPAP and endotracheal tube (ETT)]; pouch distension may lead to respiratory compromise and/or aspiration via a distal pouch fistula
- If intubation indicated, ETT tip as close to carina as possible to minimise gas flow through a fistula. Ventilatory pressures should be as low as possible
- **If any significant respiratory compromise, instigate a time critical transfer to surgical unit**
- if transferring to BCH call KIDS NTS (will conference call surgeons and PICU)

Confirmation of diagnosis

- Experienced operator to place radio-opaque 8 Fr NGT. Typically resistance is felt 10–12 cm from nostril in term baby
- do not use force (may lead to oesophageal perforation)
- AP X-ray of whole chest and abdomen
- diagnosis confirmed if NGT curled in upper oesophagus
- gastric air bubble/bowel gas confirms presence of fistula between trachea and distal oesophagus
- Do not attempt a contrast oesophagogram

MANAGEMENT ON NNU

- If respiratory support required or abdominal distension, contact surgical unit and transfer team immediately (time critical transfer); if no respiratory support required, speak directly with surgical team
- Nurse 30° head-up with head turned to side to facilitate drainage of secretions
- Pass 10 Fr Replogle tube into oesophageal pouch (see **Insertion and management of Replogle tube**)
- if Replogle tube unavailable, place 10 Fr NGT into pouch, **aspirating every 15 min**
- an NGT cannot be placed on suction, so needs regular and intermittent aspiration
- Insert until resistance is met, then withdraw by 1 cm
- Tape securely to face. Usually 10–12 cm at nostril in a term baby
- Place mittens on baby to prevent tube being pulled out
- Attach tapered end of tube to continuous low flow suction. Start pressure at 5 kPa aiming for continuous flow of secretions from upper oesophagus. Maximum pressure 10 kPa
- do not share suction with other drains e.g. chest drain
- Baby should be relaxed and pink with no respiratory distress or secretions in the mouth
- Keep nil-by-mouth
- Flush Replogle tube with sodium chloride 0.9% 0.5 mL via the sidearm every 15 min. More frequently if visible oral secretions
- If using an enteral tube to drain saliva, aspirate every 15 min, more frequently if visible oral secretions or respiratory difficulty evident

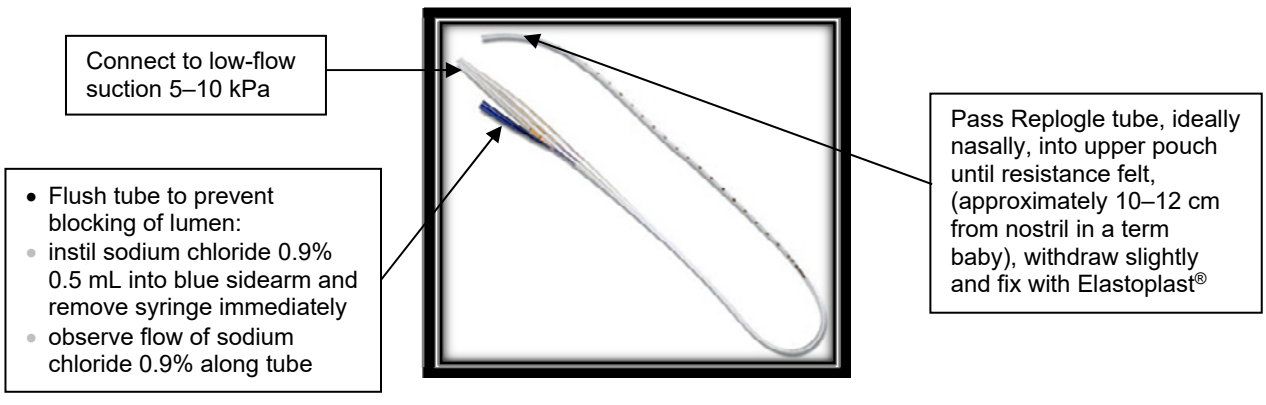
- If no movement of secretions in Replogle tube after flushing with sodium chloride 0.9% 0.5 mL via the sidearm, change tube
- Do not leave syringe attached to sidearm as this will prevent the tube working effectively
- change tube every 10 days, or daily if viscous secretions

Samples
- Obtain IV access
- Take blood for FBC, clotting, U&E, blood glucose and blood culture
- Birmingham Children's Hospital do not require a baby crossmatch sample before transfer
- Send 1 bloodspot on neonatal screening card to surgical unit with baby and mark card as 'pre-transfusion'

Fluids and medication
- Commence maintenance IV fluids (see **Intravenous fluid therapy** guideline)
- Give vitamin K IM (see **Vitamin K** guideline)
- Start broad spectrum antibiotics IV (see **Neonatal Formulary**)

Referral
- Examine baby for other associated abnormalities (e.g. cardiac murmur, anorectal abnormalities). If major congenital abnormality detected, discuss with consultant before arranging transfer for management of oesophageal atresia as this may not be appropriate
- Discuss baby's condition and treatment plan with parents and ensure they have seen baby before transfer
- Contact surgical centre to discuss transfer as soon as possible
- Obtain sample of mother's blood for crossmatch
- sample tube must be clearly hand written and labelled with mother's name, date of birth, NHS number, and date and time of collection
- complete form
  - add baby's details to ensure it is clear sample relates to mother of baby being transferred (this information is required by surgical unit blood bank)
- Complete nursing and medical documentation for transfer and send copies of X-rays by PACS. Ensure you have mother's contact details (ward telephone number or home/mobile number if she has been discharged). Surgeon will obtain verbal telephone consent if operation is required and an individual with parental responsibility is not able to attend surgical unit at appropriate time
- Contact transfer team when bed confirmed. Have available: name, gestational age, weight, ventilatory and oxygen requirements (if applicable) and mother's name and ward (if admitted)

INSERTION AND MANAGEMENT OF REPLOGLE TUBE


Connect to low-flow suction 5–10 kPa
• Flush tube to prevent blocking of lumen:
• instil sodium chloride 0.9% 0.5 mL into blue sidearm and remove syringe immediately
• observe flow of sodium chloride 0.9% along tube
Pass Replogle tube, ideally nasally, into upper pouch until resistance felt, (approximately 10–12 cm from nostril in a term baby), withdraw slightly and fix with Elastoplast®

Aim
To prevent aspiration of secretions by continuous drainage of upper oesophageal pouch

Equipment
- Replogle tube size 10 Fr + 1 spare to keep at bedside
- Low-flow suction
- Regular suction
- 2 mL IV syringe
- Sodium chloride 0.9%
- Duoderm® dressing and Elastoplast®
- Lubricant

Monitoring
- Check Replogle tube every 15 min and flush to prevent blocking of lumen by instilling sodium chloride 0.9% 0.5 mL into blue sidearm, removing syringe immediately and observing the flow of secretions along the tube. Monitor oxygen saturation, respiratory status and heart rate continuously
- For long-term Replogle use, monitor electrolytes and consider replacement therapy

Blocked tube
- Suspect if:
- no continuous flow of secretions along tube
- visible oral secretions
- baby in distress
- Clear airway with high-flow oropharyngeal suction
- Increase low-flow suction and flush Replogle tube with air, observing flow of saliva along tube
- If patency not restored, replace with new Replogle tube and return low-flow suction to previous level
- If Replogle tube replaced, alternate nostrils to avoid long-term stretching of nares

USEFUL INFORMATION
- https://bwc.nhs.uk/download.cfm?doc=docm93jijm4n2148
- http://www.tofs.org.uk

OESOPHAGEAL PERFORATION ● 1/2

INTRODUCTION

- Relatively infrequent complication in neonates and early infancy
  - most common cause in neonates is iatrogenic
- Neonates (especially preterm) requiring endotracheal intubation, nasogastric tube (NGT) insertion and oropharyngeal suction are at increased risk of trauma to:
  - pharynx
  - upper airway
  - oesophagus
- Site of injury is often at pharyngoesophageal junction where lumen is narrowed by cricopharyngeal muscle
- Contrast oesophagram and direct visualisation (ultrathin flexible endoscopy) are gold standards for diagnosis

Iatrogenic oesophageal perforation
Complications

- Pneumothorax
- Pneumomediastinum with associated infection
- Pseudo-diverticulum formation
- Surgical/subcutaneous emphysema
- Delayed initiation of feeding
- Upper GI bleeding
- Oesophageal obstruction

AT RISK

- Preterm babies (especially <1500 g)
- Babies requiring multiple intubation attempts
- Difficulty in passing or forceful attempts at NGT insertion

RECOGNITION

Clinical

- Difficulty in passing NGT
- NGT bouncing back
- Blood stained aspirates
- Bloody secretions in oropharynx
- Deterioration in clinical condition

Radiological

- Discuss with radiologist urgently if NGT appears:
  - displaced
  - to the right of the midline/vertebral spine
  - not in the stomach
  - not following normal anatomical curvature towards the stomach
  - follows a straight line in the midline towards abdomen

High index of suspicion required; above findings in isolation are common in day-to-day neonatal care

Suspect oesophageal perforation if:

- Pneumomediastinum
- Pneumothorax
- Cervical crepitus
- Subcutaneous emphysema
- Retropharyngeal gas

Difficulty passing NGT

- **Do not** make any further attempts to pass NGT
- Request a water soluble contrast study (discuss with radiologist)

OESOPHAGEAL PERFORATION ● 2/2

MANAGEMENT

- Early recognition is important (most important prognostic factor is the time between injury and initiation of therapy)
- Stop feeds
- Prescribe PN
- Remove NGT
- **do not** re-insert or manipulate NGT
- If requiring ventilatory support, **NOT** for non-invasive ventilation
- Discuss with local paediatric surgical team
- send images by PACS
- Maintain close liaison with surgical team regarding:
- antibiotics
- duration of nil-by-mouth
- progress
- Consider transfer to tertiary/surgical centre
- Keep parents updated regularly
- Document completion of duty of candour in medical records

OXYGEN ON DISCHARGE ● 1/2

OBJECTIVE

- To put an effective plan in place to allow oxygen-dependent babies to be cared for safely at home

INDICATIONS FOR HOME OXYGEN THERAPY

- Chronic lung disease with ongoing demand for additional inspired oxygen [see British Thoracic Society (BTS) guidance]

Criteria

- Clinically stable on oxygen therapy via nasal cannulae for ≥2 weeks
- SpO_2 ≥93% after 36 weeks' gestation on <0.5 L/min oxygen (if ≥0.5 L/min oxygen requirement at term then refer to paediatric respiratory team)
- Cyanotic congenital heart disease: a lower value may be appropriate, set threshold on an individual basis (liaise with paediatric cardiologists)
- Overnight pulse oximetry study when on stable oxygen for 1 week before discharge (see BTS guidelines):
  - mean SpO_2 ≥93% without frequent periods of desaturations
  - SpO_2 ≥90% for >95% of the artefact-free recording period
- If using <0.5 L/min ensure baby able to cope with short periods in air in case nasal cannulae become dislodged
- Routine continuous oxygen monitoring discontinued
- Thermo-control well established
- Feeding orally 3–4 hrly and gaining weight
  - some babies may require tube feeding, if all other criteria are met, this should not hinder discharge
- Final decision on suitability for discharge lies with consultant

PREPARATION FOR DISCHARGE

Make arrangements with parents

- Discuss need for home oxygen with parents
- Obtain consent for home oxygen supply and for sharing information with oxygen supplier. This is obligatory before supplier can be contacted with patient details
- Home oxygen assessment completed to ensure home safe for oxygen to be placed in-situ
- Arrange multidisciplinary meeting 1 week before discharge with parents/carers, community nurse, health visitor, discharge planning coordinator and local neonatal community outreach team (NCOT)
- Car seat challenge
- Arrange discharge plan (see **Discharge** guideline)

Parent training

- Resuscitation techniques (2 adults) – Supportive Training Offering Reassurance and Knowledge (STORK)/basic life support training completed
- No smoking in the house or anywhere in baby's environment
- Recognition of baby's breathing pattern, colour and movements
- Use of oxygen equipment (2 adults)
- Competence in tape application for nasal prongs and skin care (water-based emollients)
- What to do in case of emergency:
  - contact numbers
  - open access for out-of-hours
  - direct admission policy
  - fire safety and insurance advice (car and home
- Discuss DLA/blue badge advantage

Organise oxygen

- Prescribing clinician to complete Home Oxygen Order Form (HOOF) on OxyShop (www.oxyshop.org) with risk assessment
- Do not send home on <0.1 L (even if on <0.1 L in NNU. See BTS guidelines). Aim for early overnight oximetry (3-4 weeks) to ascertain if baby still requires oxygen
- If agreed in MDT, sleep study 1 week after discharge home to ensure no changes required within new environment (repeat after 3 weeks)

Discharge checklist

- Discharge plan implemented (see **Discharge** guideline)

OXYGEN ON DISCHARGE ● 2/2

- Plan discharge for beginning of week to ensure community staff available in event of problems at home
- Oxygen supply and equipment installed in the home
- Baby will go home on prescribed amount of oxygen; this may be altered on direction of medical or nursing staff, or in event of emergency
- GP and other relevant professionals (also fire and electricity companies, although oxygen supplier usually does this) informed of date and time of discharge
- Community team briefed to arrange home visit well in advance of discharge to ensure conditions suitable and equipment correctly installed
- Parents/carers trained to care for baby safely at home and have support contact numbers
- Open access to paediatric ward

AFTERCARE

- As oxygen-dependent babies (e.g. chronic lung disease) are at increased risk of contracting respiratory syncytial virus (RSV), give palivizumab and influenza vaccine (see **Immunisations** and **Palivizumab** guidelines)
- Refer to local guidelines for follow-up
- Contact Baywater Healthcare (0800 0839652) for removal of oxygen when appropriate

OXYGEN SATURATION TARGETS ● 1/1

PRINCIPLES

- Target range SpO_2 91–95% for preterm babies <36 weeks corrected gestational age, who are breathing on supplemental oxygen
- Prescribe oxygen on baby's drug chart specifying target range
- Alternative saturation targets or strategy may be specified for babies with congenital heart disease or those at risk of persistent pulmonary hypertension

Setting alarm limits

If currently <36 weeks corrected age – target range SpO_2 91–95%	If currently ≥36 weeks corrected age OR born ≥34 weeks – target SpO_2 93–97%
Babies breathing supplemental oxygen • Low alarm at 89% and high alarm at 96%	**Babies breathing supplemental oxygen** • Low alarm at 92% and high alarm at 98%
Babies breathing air • Low alarm at 90% and high alarm at 100%	**Babies breathing air** • Low alarm at 92% and high alarm at 100%

RESPONDING TO OXYGEN SATURATION ALARMS

General principles

Monitor

- Assess monitor trace and baby before increasing inspired oxygen
- If intubated and need for increasing oxygen, check for DOPE:
- displaced endotracheal tube (**D**)
- presence of secretions or blood that may be causing obstruction or kinked ET Tube (**O**)
- pneumothorax (**P**)
- equipment failure or need for change in ventilator support (**E**)

Adjust inspired oxygen

- Change inspired oxygen in increments of 1–3% at a time except before procedures or with significant desaturations below 70%. In these circumstances, see **Low alarm**
- Avoid titrating target saturation with large and frequent increases and decreases in inspired oxygen
- wide fluctuations increase risk of retinopathy of prematurity in preterm babies
- small frequent tweaking of inspired oxygen by 1–3% between 40–50% oxygen is much better than intermittently swinging between 30–80% oxygen to achieve same target range
- use of OxyGenie™ technology for oxygen saturation targeting, if using SLE 6000 ventilators

If it is necessary to increase inspired oxygen by >5–10%, or to introduce (or change) CPAP or ventilation, discuss with doctor or ANNP immediately

Specific circumstances

High alarm

- Silence alarm and observe for an alarm cycle (3 min)
- If alarm still sounding after a cycle, decrease inspired oxygen by 1–3%
- Continue reducing inspired oxygen by 1–3% every alarm cycle until saturation stable in desired range

Low alarm

- Never silence alarms without reviewing baby
- Assess waveform and heart rate
- Baby: check for DOPE and manage appropriately
- If desaturation persists after above checks, increase inspired oxygen by 1–3% for moderate desaturation (>70%)
- significant desaturations (<70%), double baseline inspired oxygen (increase by ≥20%) until SpO_2 increases to 90%, then wean rapidly to within 3% of baseline inspired oxygen

Handling or procedures

- If history of significant desaturation with handling or procedures, increase inspired oxygen by 5–10% before handling or procedure
- may require ventilator changes to increase mean airway pressure (discuss with tier 2 staff)
- After procedure, once SpO_2 stabilises, wean inspired oxygen rapidly to baseline

Labile cases

- Some sick babies will be particularly labile and it is challenging to maintain SpO_2 in target range. In rare cases, individualised adjustments to alarm settings may be necessary after discussion with medical team

PAIN ASSESSMENT AND MANAGEMENT ● 1/5

INTRODUCTION

- Discomfort, pain or stress can be associated with routine care and invasive procedures. Babies are unable to report pain; use observational skills and clinical judgment

Key recommendations

- Routine assessments to detect pain using a validated assessment tool
- Minimise number of painful procedures
- Prevent/reduce acute pain from invasive procedures using non-pharmacological and pharmacological methods
- Anticipate and treat post-operative pain

Types of pain

Acute pain	Skin-breaking procedures or tissue injury caused by diagnostic or therapeutic interventions
Established pain	Occurs after surgery, localised inflammatory conditions, birth-related trauma
Prolonged/chronic pain	Results from severe diseases e.g. necrotising enterocolitis (NEC), meningitis. Pathological pain state persisting beyond normal tissue healing time

Signs

- Lack of behavioural responses does not exclude pain

Physiological changes	Behavioural changes	Anatomical changes	Body movements
• Increase in: ◦ heart rate ◦ blood pressure ◦ respiratory rate ◦ oxygen consumption ◦ mean airway pressure ◦ muscle tone ◦ intracranial pressure ◦ skin blood flow • Decrease in: ◦ oxygen saturation and transcutaneous oxygen levels ◦ skin blood flow • Apnoea ◦ shallow breathing • Fixed heart rate	• Change in facial expression: ◦ grimace ◦ brow bulge ◦ eye squeeze ◦ deepening naso-labial furrow ◦ nasal flaring ◦ tongue curving or quivering • Crying • Whimpering • 'Silent' cry (intubated babies) • Decreased sleep • Heightened responses	• Dilated pupils • Sweating • Flushing • Pallor	• Fisting • Tremulousness • Thrashing limbs • Limb withdrawal • Writhing • Arching back • Head banging • Finger splaying • Cycling

- Sudden pain and distress may indicate acute deterioration e.g. bowel perforation
- Physiological changes cannot be sustained long-term

PAIN ASSESSMENT

- Assess within 1 hr of admission
- Frequency of further assessments will depend on baby's clinical condition, underlying diagnosis and pain score (see **Frequency of assessment**)

Pain assessment tools

- **Separate tools may be needed to assess acute and prolonged pain**
- Use validated pain assessment tools [Pain Assessment Tool (PAT) and Premature Infant Pain Profile (PIPP)]
- See **Abstinence syndrome** guideline for assessment of babies with neonatal abstinence syndrome

Pain assessment not indicated/unsuitable

Not indicated	Unsuitable
• Pharmacologically paralysed babies; provide appropriate pain relief	• Distress is expected but easily relieved (e.g. ventilated baby requiring suction) • For simple, routine procedures e.g. capillary blood sampling • second person (parent, nurse or healthcare practitioner to provide support and comfort baby)

Use of pain assessment tool
- Note gestational age
- Observe baby's behaviour for 15–30 sec then gently touch baby's limb to determine muscle tone/tension (can be done during routine handling)
- Note:
- physiological conditions that may influence score (in cyanotic heart disease, baby's colour may score normal unless there is a change in the intensity of the cyanosis or duskiness due to pain)
- medications that may affect behaviour or physiological responses
- environmental triggers (sudden bright lights, noise, activity) may cause a stress response
- Document on chart or in notes at time of score
- When score is above tool's recommended thresholds, initiate comfort measures or analgesia

Frequency of assessment
- **All** babies to have pain assessment within 1 hr of admission
- Minimum frequency of subsequent assessments depends on level of care
- **intensive care**: hourly with observations
- **high dependency**: 4-hrly
- **special care**: as condition dictates
- **post-operatively**: hourly for first 8 hr, then 4-hrly until 48 hr post-op (more frequently if signs of distress/discomfort)
- If baby shows signs of distress/discomfort perform additional assessments

PAIN MANAGEMENT

Indications
- Birth trauma
- Iatrogenic injury
- Before, during and after **any** painful procedure
- Severe illness e.g. NEC, meningitis
- To aid ventilation
- Preparation for transfer if ventilated
- Whilst undergoing therapeutic hypothermia
- Post-operatively
- End-of-life care
- Formal assessment indicates pain
- If non-pharmacological techniques are ineffective or not appropriate, progress to pharmacological agents (e.g. post-surgery, severe illness, major injury, congenital malformations and palliative care)

Non-pharmacological pain relief
- Gently repositioning baby
- Light swaddling (blanket/nest), prolonged restrictive swaddling may be associated with increased risk of developmental hip dysplasia
- Comfort/containment holding
- Reducing light, noise, and activity around baby
- Soothing voice
- Nappy change
- Non-nutritive sucking (NNS) (dummy or gloved finger) [see **Non-nutritive sucking (NNS)** guideline]
- Kangaroo care (see **Kangaroo care** guideline)
- Breastfeed (see **Breastfeeding** guideline)
- Sucrose
- Mother's expressed breast milk (MEBM) – no additives

Reassess after 30 min

- If pain score in upper range, institute comfort measures and administer prescribed analgesia/seek medical review
- If score continues to rise, consider increasing dose of analgesia and reassess after 30 min
- if clinical concerns – medical review
- If score constantly below baseline and analgesia maintained, reduce dosage
- Record effectiveness of pain management in care plan

Sucrose

- Sucrose 24% solution and breast milk provide a quick, short-term analgesic effect (given orally)
- NNS increases effectiveness
- Use in conjunction with environmental and behavioural measures to relieve pain (e.g. positioning, swaddling, containment holding, kangaroo care)
- may be given to ventilated babies with care

Contraindications to sucrose

Do not use	May not be effective
• <28 weeks' gestation – use MEBM • High risk of NEC – use MEBM • Nil-by-mouth (if due to surgical problem, sucrose may be appropriate, discuss with surgeon) • Sedated or on other pain medications • Diabetic mother (until blood glucose stabilised) • Known carbohydrate malabsorption or enzyme deficiency	• Baby with neonatal abstinence syndrome • Baby just been fed • Exposed to chronic in-utero stress • >6 months

Administration

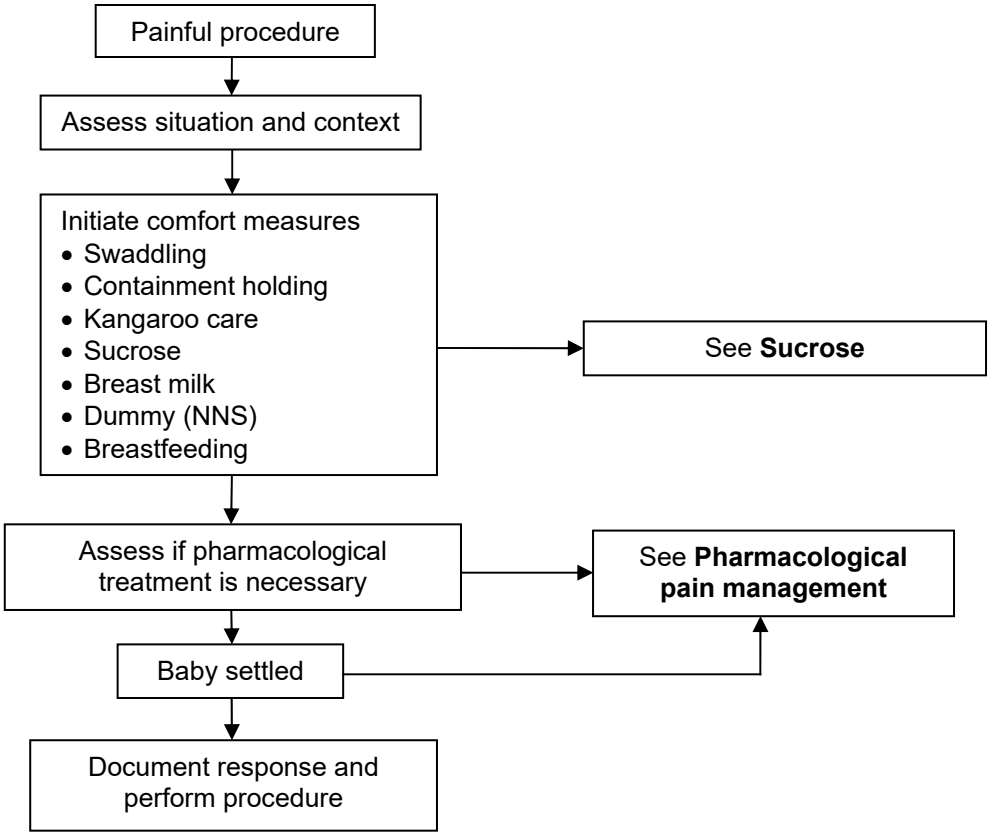
- Use commercially available sucrose 24% solution and follow manufacturer's guidelines regarding storage and use
- Maximum 8 doses in 24 hr
- Avoid risk of choking/aspiration – ensure baby is awake
- Drop dose onto tongue, buccal membrane, or dummy and **wait 2 min** before starting procedure
- For procedures lasting >5 min, repeat dose (maximum 2 further doses)
- Continue environmental and behavioural management strategies during procedure
- Observe baby's cues and allow 'time-out' to recover
- Document administration of sucrose as per local policy

Gestation	Dose of sucrose 24%
28^{+0}–30^{+6} weeks	0.1 mL (max 0.3 mL per procedure)
≥31^{+0} weeks and 1000–2000 g	0.2 mL (max 0.6 mL per procedure)
>2000 g	0.5 mL (max 1.5 mL per procedure)

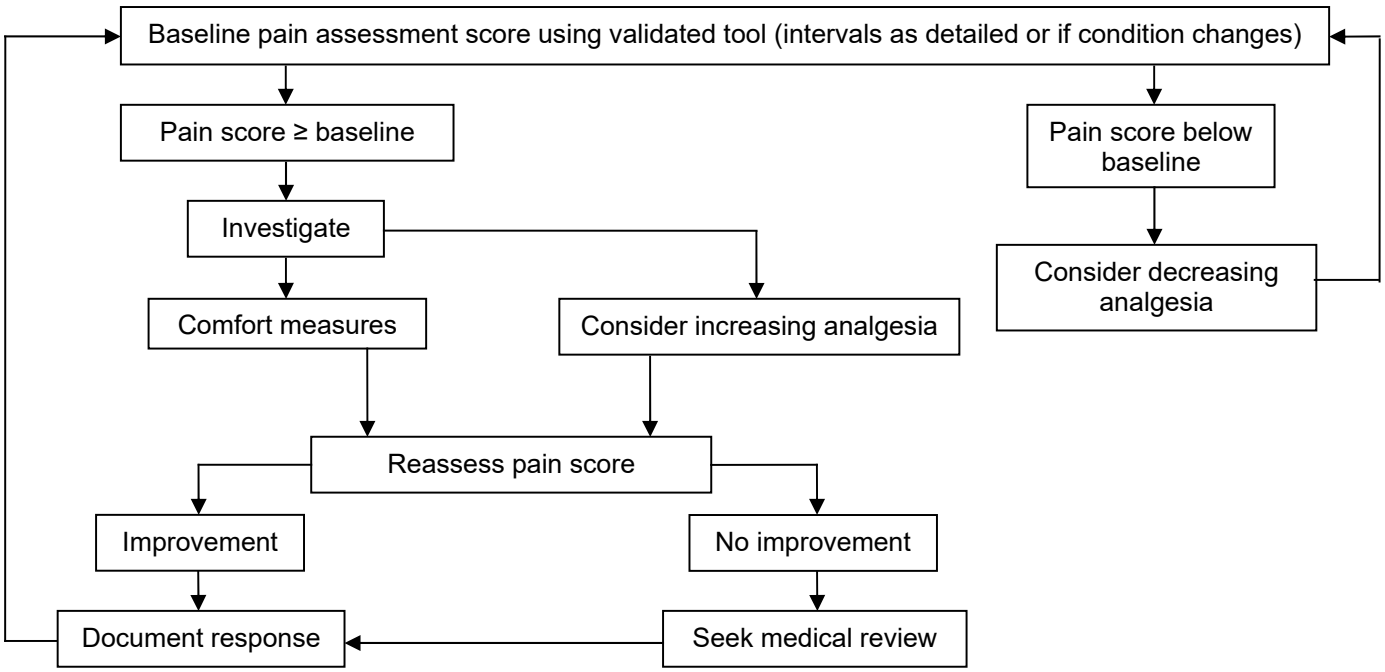
Pharmacological pain management

- Give medication in conjunction with non-pharmacological measures
- The following drugs may be useful:
- fentanyl
- morphine
- paracetamol
- Details of these drugs can be found in the **Neonatal Formulary**

Management of procedural pain



Management of prolonged or chronic pain



Suggested medication for procedures

Specific situations

Non-urgent endotracheal intubation	Mechanical ventilation	Chest drain insertion	CT/MR imaging	Laser therapy for ROP	Therapeutic hypothermia
• Fentanyl IV • Atropine IV • Suxamethonium IV	• Morphine/ continuous IV infusion	• Morphine IV • Lidocaine SC	• Sedation may be unnecessary if baby fed and swaddled • Chloral hydrate - oral or rectal • Midazolam IV/buccal/oral/ intranasal	• Morphine continuous IV infusion	

Simple surgical procedures

Abdominal drain insertion	Broviac line removal	Wound dressing/drain removal	Application of silo bag for gastroschisis
• Morphine continuous IV infusion • Lidocaine SC	• Paracetamol oral/rectal • Lidocaine SC • Sucrose oral	• Paracetamol oral/rectal • Sucrose oral	• Paracetamol rectal

PALIVIZUMAB ● 1/2

Based on Chapter 27a of Green Book

DEFINITION

Palivizumab is a humanised monoclonal antibody produced by recombinant DNA technology used to prevent severe disease caused by respiratory syncytial virus (RSV)

INDICATIONS

High risk – bronchopulmonary dysplasia (BPD) [also known as chronic lung disease (CLD)]

- Moderate or severe BPD in preterm babies defined as:
  - preterm babies with compatible X-ray changes who continue to receive supplemental oxygen or respiratory support at 36 weeks' post-menstrual age **and**
  - in the light and dark shaded area in **Table 1** (at start of RSV season 1st October)
- Babies with respiratory disease who are not necessarily pre-term but are aged <2 yr and who remain on oxygen at start of RSV season are considered to be at higher risk. This may include those with conditions including:
  - pulmonary hypoplasia due to congenital diaphragmatic hernia
  - other congenital lung abnormalities (sometimes involving heart disease or lung malformation)
  - interstitial lung disease;
  - **and** including those receiving long-term ventilation at the start of the season

High risk congenital heart disease (CHD) defined as:

- Preterm babies with haemodynamically significant, acyanotic CHD at the chronological ages at the start of RSV season and gestational ages covered by light grey shaded area in **Table 1**
- Cyanotic or acyanotic CHD plus the following significant co-morbidities, particularly if multiple organ systems are involved:
  - Down syndrome
  - preterm delivery (<35 weeks)
  - BPD/CLD
  - pulmonary hypertension
  - immune deficiency – DiGeorge, combined immune-deficiency
  - heart failure – diuretic therapy, oral inotropic therapy
  - cyanosis with SpO_2 <85%
  - those due transplantation or cardiac surgery

Children with severe combined immunodeficiency syndrome (SCID)

- Children aged <2 yr who have SCID until immune reconstituted

Table 1: Chronological age cut off for palivizumab

	Gestational age at birth (whole weeks)						
Chronological age (months)	≤24^{+0}	24^{+1}–26^{+0}	26^{+1}–28^{+0}	28^{+1}–30^{+0}	30^{+1}–32^{+0}	32^{+1}–34^{+0}	>34^{+1}
<1.5							
1.5 to <3							
3 to <6							
6 to <9							
≥9							

The following co-morbidities are NOT acceptable under the guidance (little/no evidence for RSV prophylaxis)

- Haemodynamically insignificant CHD (no therapy)
- Repaired CHD
- Arrhythmias
- Recovered from BPD
- Children aged >2 yr

PROCEDURE

- Identify babies eligible for palivizumab prophylaxis at discharge from NNU – document in discharge summary
- Babies eligible for palivizumab will also be eligible for annual influenza vaccination if aged >6 months by early October

- advise GP in advance to include in annual influenza vaccination programme
- inform parents of benefits and risks of prophylaxis at follow-up clinics before RSV season
  - provide leaflet and discussion with consultant and neonatal community outreach team (NCOT)
  - obtain verbal consent
- Consultant will complete **Blueteq** form for each patient meeting the criteria above
- if the consultant considers a baby outside of the above criteria would benefit from palivizumab treatment, an application for approval should be made through the regional individual funding request process
- Paediatric cardiology team at Birmingham Children's Hospital will:
- identify late preterm/term babies with CHD meeting criteria for prophylaxis
- complete **Blueteq** form
- notify local team (including **Blueteq** approval number)
- 5 doses monthly in RSV season at the beginning of October, November, December, January and February. If the RSV season is prolonged, the course may be extended to a maximum of 7 doses in total
- give appointment for subsequent doses at palivizumab clinic (if held)
- where possible, administer first dose before start of RSV season
- 15 mg/kg by IM injection into antero-lateral aspect of thigh
- Order palivizumab injection from local community or hospital pharmacy (this can take some days)
- Palivizumab must be stored at 2–8°C. Full administration instructions are provided in the 'Summary of product characteristics' (SPC)
- Split between 2 sites if >1 mL (final concentration when reconstituted 100 mg/mL)

DOCUMENTATION

- After immunisation, document the following in case notes as well as in Child Health Record (Red Book):
- consent gained from parents
- vaccine given and reasons for any omissions
- site of injection(s) in case of any reactions
- batch number of product(s)
- expiry date of product(s)
- legible signature of person administering immunisations
- adverse reactions
- Sign treatment sheet
- Update problem sheet with date and immunisations given

PARENTERAL NUTRITION ● 1/4

DEFINITION

Parenteral nutrition (PN) is the IV infusion of nutrients for the purpose of tissue maintenance, metabolic requirements and growth promotion in babies unable to tolerate full enteral feeds

Seek advice from your local PN pharmacist or local nutrition team

INDICATIONS FOR PN

- Newborn babies – commence PN if:
  - <31^{+0} weeks' gestation
  - ≥31^{+0} weeks' gestation – if sufficient progress not made with enteral feeding in first 72 hr after birth
  - unlikely to establish sufficient enteral feeding, e.g. babies with congenital gut disorder or critical illness (e.g. sepsis)
- Babies who have previously established some enteral feeds, commence PN if:
  - enteral feeds stopped and unlikely to be restarted within 48h (preterm) or 72 hr (term)
  - enteral feeds stopped for >24 hr and unlikely to be sufficient progress with enteral feeding within further 48 hr
- Commence PN as soon as decision made baby meets criteria (within 8 hr of decision at latest)

MODE OF DELIVERY

- Administer PN continuously over 24 **hr**
  - Shield syringes, bags and infusion sets from light

Peripheral PN

- PN should be ideally delivered centrally (high glucose and electrolyte concentrations result in a high osmolarity – limiting nutrition given peripherally)
- Depending on aqueous bag composition, local policy may permit peripheral administration of certain products in certain circumstances (i.e. start-up bags) – check local policy before prescribing
- Running lipid peripherally in addition to aqueous phase may prolong the life of the peripheral cannula

Central PN

- Requires placement of a central catheter [see **Long line insertion (peripherally sited)** guideline] with tip in either superior vena cava or inferior vena cava
- All PN with glucose concentration >10% should be infused centrally
- Infuse PN via a dedicated lumen
  - continuous vancomycin, sodium chloride and potassium chloride infusions may be administered simultaneously with PN via a separate lumen; seek advice from pharmacist
  - if necessary, vancomycin can be infused through the same lumen as PN
- If access difficult, discuss PN drug compatibilities with pharmacist

Never administer calcium, magnesium and phosphate containing fluid through the same lumen as PN

Central PN [long lines and umbilical venous catheters (UVC)] can introduce infection

CONSTITUTION OF PN

- For practical and safety reasons, standard bags are preferred as neonatal nutritional requirements are largely predictable (see **Nutrition and enteral feeding** guideline)
- WMNODN standardised PN bags are available to order across the network and will meet nutritional requirements (in line with NICE/ESPGHAN) when prescribed at the recommended rates [see https://www.teamwmcn.nhs.uk/download/docm93jijm4n21262.pdf?ver=34246]

Additions to PN to be made within an aseptic pharmacy only

- If additional electrolytes required, it is recommended they are infused alongside standardised PN (see **Central PN**) to avoid use of 'bespoke' bags

Volume
- PN provided primarily for nutrition
- although fluid and nutrition are closely linked and volume needs to be considered carefully, the concepts are not interchangeable e.g. providing 150 mL/kg/day fluid does not guarantee provision of adequate nutrition
- may be beneficial to give concentrated aqueous phase solutions to enable administration of additional drugs without compromising nutritional intake (WMNODN maintenance preterm 15 bag is a concentrated formulation)

Protein/amino acid
- Initial PN bag to contain 1.5–2 g/kg/day
- Target protein intake, by day 5 of life, (regardless when PN was commenced):
- preterm babies: 3–4 g/kg/day
- term babies: 3 g/kg/day
- Administer sufficient carbohydrate to facilitate the accretion of protein (approximately 25 kcal/g protein)

Glucose
- 6–9 g/kg/day in first 24 hr – take PN and additional fluids into consideration
- Increase glucose intake as tolerated to optimise calorie intake to maximum of 9– 16 g/kg/day
- If severe or persistent hyperglycaemia develops, commence insulin infusion – see **Administration of Actrapid® insulin (soluble insulin)** in **Hyperglycaemia** guideline

Electrolytes
- Sodium: ≥3 mmol/kg/day in preterm babies who have commenced natriuresis
- Potassium: ≥2 mmol/kg/day from day 2–3
- Babies given electrolytes solely as chloride salts can develop hyperchloraemic metabolic acidosis (consider adding acetate to PN, where available)
- Monitor serum phosphate twice weekly; aim to maintain at around 2 mmol/L

Micronutrients
- Calcium: 0.8–1 mmol/kg/day first 48 hr of life, increased to 2 mmol/kg/day thereafter
- Phosphate: 1 mmol/kg/day first 48 hr of life, increased to 2 mmol/kg/day
- monitor phosphate – higher doses may be required
- if possible, use organic phosphate compounds
- Magnesium: 0.18–0.2 mmol/L

Trace elements
Peditrace®
- Addition of trace element admixture (Peditrace®) may shorten the shelf-life of standard bags to 7 days. However, trace elements (Peditrace) are now included in the WMNODN 2023 standard PN formulations with an 84-day expiry. Zinc and selenium will be contained within standard aqueous feed bags
- If baby on short-term PN and receiving some milk feeds, trace elements may not be required
- If baby on PN >2 weeks with enteral feed intake of <50% and not receiving Peditrace®, discuss with PN pharmacist/dietitian

Fat
- 2 lipid emulsions used routinely on NNU: Intralipid® (soya bean origin) and SMOF lipid (blend of soya bean, MCT fat, olive oil and fish oils)
- Consider SMOF lipid for babies with conjugated bilirubin >50µmol/L
- Commence lipid 1–2 g/kg/day IV when commencing aqueous phase
- increase by 0.5–1 g/kg/day to maximum 3–4 g/kg/day
- all lipid to be infused over 24 hr

Vitamins
- Vitlipid (fat soluble vitamins) + Solivito (water soluble vitamins) are added to lipid syringes (Intralipid bags do not contain vitamins)
- Should be given within 48 hr of starting PN

MONITORING

	Initiation of PN/acutely unwell	Stable baby on maintenance PN
• Fluid input/output	• Daily	• Daily
• Blood glucose	• Daily if blood glucose >11 mmol/L, urine glucose	• Twice weekly
• U&Es	• Daily	• Twice weekly
• Blood pH	• Daily	• Twice weekly
• Ca • PO_4 • Mg	• Daily	• Twice weekly
• LFTs	• Weekly	• Weekly
• Weight	• Daily	• 3 x weekly
• Length • Head circumference	• Weekly	• Weekly
• Serum triglycerides* • Fat soluble vitamins A, D, E • Zinc • Copper • Manganese • Selenium • B_{12} and folate • Ferritin	• 4-weekly	• 4-weekly

*Not always practical – follow local unit policy

COMPLICATIONS

Catheter-related: **[see *Long line insertion (peripherally sited)* guideline]**

- Peripheral catheters: extravasations and skin sloughs
- Blood stream and/or line infection

Electrolyte abnormalities

- Electrolyte and acid-base disturbances

Metabolic

- Hyper/hypoglycaemia, osmotic diuresis
- Metabolic bone disease: mineral abnormalities (Ca/PO_4/Mg)
- Hyperlipidaemia and hypercholesterolaemia
- Conjugated hyperbilirubinaemia

PN-associated cholestatic hepatitis (see *Liver dysfunction in preterm babies* guideline)

- Can occur with prolonged PN (>10–14 days)
- probably due to combination of PN hepato-toxicity, sepsis and reduced oral feeding
- often transient
- usually manifests as rising serum bilirubin (with increased conjugated component >50 micromol/L) and mildly elevated transaminases
- leads to deficiencies of fatty acids and trace minerals in enterally fed babies
- even small enteral feeds will limit or prevent this problem and therefore trophic feeds (10-20ml/kg/d) should be given to all babies on PN unless there are contraindications such as acute clinical instability or NEC
- consider other causes of hyperbilirubinaemia (PN-induced cholestasis is diagnosis of exclusion) e.g. CMV, hypothyroidism
- if failure to progress with enteral feeding in a timely fashion, seek advice from unit nutrition team, neonatal dietitian or paediatric gastroenterologist

WEANING PN

- Commence enteral feeds as soon as possible
- see **Nutrition and enteral feeding** guideline for initiating and advancing enteral feeds

- Do not wean PN until total fluid requirement reached; **either** 150 mL/kg/day **or** 165 mL/kg/day depending on type of feed (unless fluid restricted)
- 165 mL/kg/day is the target for babies receiving fortified EBM/DEBM or Nutriprem 1; 150 mL/kg/day is the target for babies receiving SMA GP1 preterm formula
- When advancing enteral feedings, proportionally reduce rate of PN administration to maintain desired total fluid volume
- When weaning PN decrease aqueous and lipid simultaneously **in proportion** to ensure correct ratio of calorie distribution from fat and carbohydrate.
- Ratio dependent on total volume of aqueous phase + lipid, e.g. if increasing feed by 1 mL/hr, decrease aqueous phase by 1 × (aqueous phase mL/hr/aqueous phase ml/hr + lipid mL/hr), and decrease lipid by 1 × (lipid mL/hr/aqueous phase ml/hr + lipid mL)
- see WMNODN https://www.teamwmcn.nhs.uk/download/docm93jijm4n21262.pdf?ver=34246 for details on how to wean standardised network PN
- Assess nutrient intake from both PN and enteral feed in relation to overall nutrition goals
- If enteral vitamins required, commence when lipid syringe infusion <10 mL/kg/day
- For babies born <28 weeks, stop PN within 24 hr of tolerating 140–150 mL/kg/day of enteral feeds
- For babies born ≥28 weeks, stop PN within 24 hr of tolerating 120–140 mL/kg/day of enteral feeds (see **Nutrition and enteral feeding** guideline)
- add HMF to M/DBM at 100 mL/kg/day to maintain recommended nutrient intake (see **Nutrition and enteral feeding** guideline)

PATENT DUCTUS ARTERIOSUS ● 1/4

RECOGNITION AND ASSESSMENT

Definition

- Persistent patency of the ductus arteriosus (PDA) is a failure of functional ductal closure by 48 hr or anatomical closure by aged 3 weeks

Factors associated with delayed closure

- Prematurity (significant PDA affects approximately 30% of very-low-birth-weight babies)
- Lack of antenatal corticosteroid prophylaxis
- Surfactant-deficient lung disease
- Hypoxaemia
- Volume overload

Adverse effects of PDA

- Haemodynamic consequences of left-to-right shunt in preterm babies can prolong ventilatory support and are associated with mortality and morbidity [chronic lung disease, pulmonary haemorrhage, intraventricular haemorrhage, necrotising enterocolitis (NEC) and retinopathy of prematurity]
- Increased pulmonary blood flow (leading to increased work of breathing and respiratory deterioration)
- Reduced systemic blood flow (leading to acidosis and hypotension)

Signs

- Can be absent even in the presence of a significant duct in first 7 days of life
- A significant left-to-right shunt is suggested by:
  - bounding pulses and wide pulse pressure (i.e. >25 mmHg)
  - hyperdynamic precordium (excessive movement of precordium)
  - low-pitched systolic or continuous murmur over left upper sternal edge (absence of a murmur does not exclude significant PDA)
  - signs of cardiac failure (tachypnoea, tachycardia, hepatomegaly, pulmonary oedema, generalised oedema etc.)
  - poor perfusion (hypotension, poor capillary refill, mottled skin and persistent acidosis)
  - increased or persistent ventilatory requirements

Differential diagnosis

- Other cardiac pathology (e.g. congenital heart disease, including duct-dependent lesions, arrhythmias or cardiomyopathy)
- Sepsis

INVESTIGATIONS

- SpO_2 monitoring
- Chest X-ray (cardiomegaly? pulmonary plethora?)
- Echocardiography
  - to detect duct-dependent cardiac lesions and other cardiac pathologies that are difficult to exclude clinically
  - if considering treatment with prostaglandin inhibitor
  - echocardiographic signs of significant PDA includes:
    - size of PDA (>1.5 mm)
    - volume loading of left atrium (LA/aorta ratio >1.5)
    - volume loading of left ventricle
    - velocity and flow pattern of ductal flow (Vmax < 2 m/sec, pulsatile flow etc.)

IMMEDIATE TREATMENT

General measures

- Optimise oxygenation by appropriate ventilatory management
- Use of a higher PEEP (i.e. ≥5 cm H_2O) can help minimise effects of pulmonary oedema and risk of pulmonary haemorrhage
- Treat anaemia – maintain Hb ≥100 g/L with blood transfusion (consider concurrent dose of furosemide IV)
- Before starting medication, consider restricting fluid intake to 60–80% (e.g. from 150 mL/kg/day to 90–120 mL/kg/day)

- If fluid overload or pulmonary oedema, give 1 dose of furosemide IV in accordance with **Neonatal Formulary**

Specific measures
- Aim to convert haemodynamically significant PDA into insignificant PDA as complete duct closure may take weeks or months

Pharmacological treatment with prostaglandin inhibitor to initiate closure
Discuss with senior before starting or altering pharmacological treatment for PDA
- Ibuprofen IV is the drug of choice for this purpose – indometacin is not currently available in the UK
- if ibuprofen contraindicated discuss use of paracetamol with consultant (see below):
  - be aware of the lack of data for long-term safety on the developing immature brain
- Pharmacological treatment is best used aged ≤2 weeks but can be effective ≤6 weeks

Indications for pharmacological treatment
- Babies born <34 weeks' gestation with significant PDA – on clinical and/or echocardiographic assessment
- Includes ventilatory/CPAP dependent babies or PDA with haemodynamic effects (i.e. cardiac failure or poor perfusion)
- Monitor babies with non-significant PDA carefully and treat if becomes significant

IBUPROFEN

Contraindications
- Duct-dependent cardiac lesion
- Significant renal impairment: urine output <1 mL/kg/hr or creatinine >120 micromol/L
- Significant thrombocytopenia, i.e. platelet count $<50 \times 10^9$/L (course started or next dose given only after platelet transfusion)
- Suspected or definite NEC or gastrointestinal perforation
- Active phase of significant bleeding (gastrointestinal or severe intracranial) – treat coagulopathy before starting course (see **Coagulopathy** guideline)

Dose
- Calculate carefully and prescribe individually on single dose part of prescription chart so that contraindications checked before each dose
- Administer IV in accordance with **Neonatal Formulary**

Monitoring during treatment
- Check the following before each dose:
- creatinine (<120 micromol/L)
- urine output (>1 mL/kg/hr)
- platelet count ($\geq 50 \times 10^9$/L with platelet infusions if needed)
- If any parameter abnormal withhold dose until it normalises

PARACETAMOL

Contraindications
- Duct dependent cardiac lesion

Dose
- **Dose and regimen as per local trust policy or formulary**
- IV loading dose 20 mg/kg followed 6 hr later by IV maintenance dose of 10 mg/kg/dose 6-hrly. (This lower IV cumulative dose 40–50 mg/kg/day has been found to be effective and safe in RCTs)
- **Paracetamol 15 mg/kg/dose 6-hrly oral (total cumulative dose 60 mg/kg/day) has also been shown to be safe and effective in RCTs – consider this route if IV access difficult**
- Repeat echo 3–5 days after commencing treatment
- Duration of treatment is 3 days but can be extended by a maximum of 3 more days if PDA remains significant (based on clinical or echo evaluation)

Monitoring during treatment

- Measure serum paracetamol trough levels before 3rd, 6th and 9th maintenance doses. Theraputic range 15–25 mg/L
- If all 3 levels ≤25 mg/L and dose and frequency unchanged no further levels needed
- if levels >25 mg/L, first reduce frequency to 8-hrly before reducing dose by 10–15%. Check levels before 3rd, 6th and 9th doses after every change
- LFTs before treatment, then daily for 6 days
- Echo day 3–5 of treatment

SUBSEQUENT MANAGEMENT (both drugs)

- Aim to avoid concomitant nephrotoxic drugs e.g. gentamicin or vancomycin. Monitor levels or use an alternative drug
- Observe for signs of feed tolerance (feeds cautiously initiated or continued during treatment – briefly stopped during actual infusion)
- Monitor clinical signs of PDA and baby's progress
- Echocardiography (if clinically indicated), repeated after 2–3 days of completion
- Fluid gradually liberalised after treatment based on:
- daily weight (weight gain suggests fluid retention)
- serum sodium (dilutional hyponatraemia common)

Persistence or recurrence of asymptomatic PDA

- **Persistence of murmur does not necessarily indicate return of PDA**
- Echocardiogram sometimes demonstrates physiological branch pulmonary stenosis
- If baby with asymptomatic murmur is making progress, plan echocardiography before discharge to decide follow-up

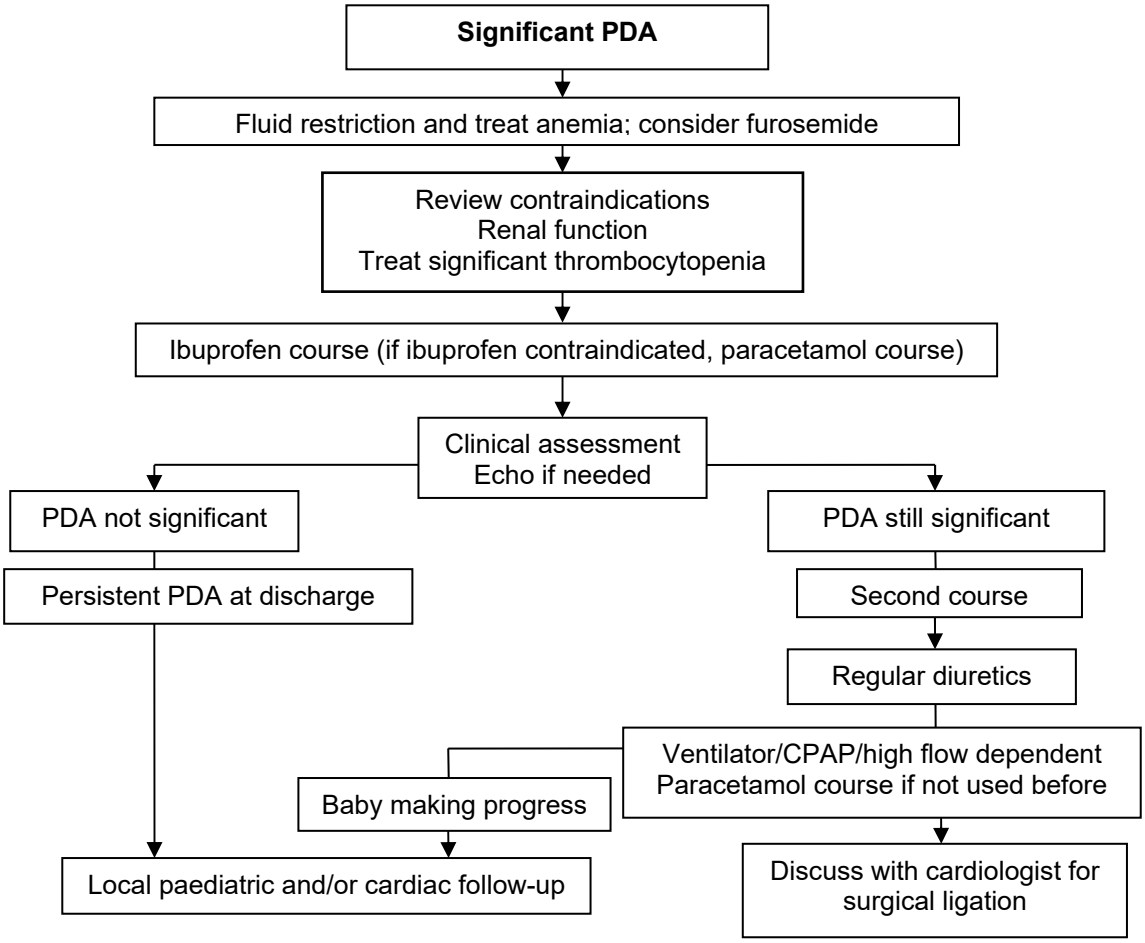
Persistent significant PDA and surgical referral

- If PDA significant 48 hr after completion of first course of prostaglandin inhibitor, use second course of ibuprofen
- If PDA still significant but baby making progress (i.e. can be extubated or come off CPAP):
- commence regular diuretics (furosemide + amiloride/spronolactone) to help control haemodynamic effects/cardiac failure – in accordance with **Neonatal Formulary**
- monitor closely
- If PDA still significant and baby ventilatory or CPAP/high flow dependent, discuss with cardiac centre for surgical ligation when:
- prostaglandin inhibitor contraindicated
  - if ibuprofen contraindicated, use paracetamol
- prostaglandin inhibitor not indicated (≥34 weeks with cardiac failure not controlled by diuretics)
- prostaglandin inhibitor ineffective (usually after giving second course). Paracetamol used as third course if not used before, while considering surgical ligation
- Discuss further cardiac assessment and surgical ligation of PDA with cardiologist at regional cardiac centre and transport team – follow local care pathway (e.g. West Midlands PDA Ligation Referral Pathway)
- After surgical ligation, keep baby nil-by-mouth for 24 hr before gradually building up feeds (because of risk of NEC)

DISCHARGE POLICY FOR PERSISTENT PDA

- If PDA persistent clinically or echocardiographically at discharge or at 6 weeks follow-up, arrange further follow-up in cardiac clinic (locally or at cardiac centre depending on local practice)
- If PDA reviewed locally still persistent at aged 1 yr or if clinically significant during follow-up (cardiac failure or failure to thrive), refer to paediatric cardiologist at regional cardiac centre to consider closure (first option is usually catheter closure)

Medical treatment of persistent PDA <34 weeks' gestation



PERICARDIOCENTESIS • 1/1

INDICATION

Drain a pericardial effusion only if there is cardiovascular compromise. If time allows, discuss with paediatric cardiologist before drainage

PERICARDIAL EFFUSION

Common causes

- Neonatal hydrops
- Extravasation of fluids from migrated long lines

Clinical signs

- Sudden collapse in baby with long line or umbilical venous catheter *in situ* – always consider pericardial tamponade
- Tachycardia
- Poor perfusion
- Soft/muffled heart sounds
- Cardiomegaly
- Decreasing SpO_2
- Arrhythmias

Investigations

- Chest X-ray: widened mediastinum and enlarged cardiac shadow
- Echocardiogram or cardiac point of care ultrasound

EQUIPMENT

- Sterile gown and gloves
- Sterile drapes
- Dressing pack with swabs and plastic dish
- 22/24 G cannula
- 5–10 mL syringe with 3-way tap attached
- Cleaning solution as per unit policy
- Lidocaine

PROCEDURE

Consent and preparation

- If time allows, inform parents and obtain consent (verbal or written)
- If skilled operator available, perform under ultrasound guidance
- In an emergency situation, the most experienced person present performs procedure without delay and without ultrasound guidance
- Ensure baby has adequate analgesia with IV morphine and local lidocaine instillation

Drainage

- Maintain strict aseptic technique throughout
- Clean skin around xiphisternum and allow to dry
- Infiltrate with local anaesthetic and wait for it to work
- Attach needle to syringe and insert just below xiphisternum at 30° to skin and aiming toward left shoulder
- Continuously aspirate syringe with gentle pressure as needle is inserted. As needle enters pericardial space there will be a gush of fluid, blood or air
- Send aspirated fluid for microbiological and biochemical analysis
- Withdraw needle

AFTERCARE

- Cover entry site with clear dressing (e.g. Tegaderm™/Opsite)
- Discuss further management with paediatric cardiologist

POLYCYTHAEMIA • 1/2

RECOGNITION AND ASSESSMENT

Definition

- Peripheral venous haematocrit (Hct) >65% or Hb >220 g/L
- Symptoms rarely occur with peripheral Hct of <70%
- Hct peaks at 2 hr after birth and then decreases with significant changes occurring by 6 hr

Clinical consequences

- Hyperviscosity
- Decreased blood flow and impaired tissue perfusion
- Increased risk of thrombus formation

Complications

- Cerebral micro-infarction and adverse neurodevelopmental outcome
- Renal vein thrombosis
- Necrotising enterocolitis (NEC)

Causes

- Intra-uterine increasd erythropoiesis
  - placental insufficiency (SGA)
  - postmaturity
  - maternal diabetes
  - maternal smoking
  - chromosomal abnormalities: trisomy 21, 18, 13
  - Beckwith–Wiedemann syndrome
  - congenital adrenal hyperplasia
  - neonatal thyrotoxicosis
  - congenital hypothyroidism
- Erythrocyte transfusion
  - maternal-fetal transfusion
  - twin-to-twin transfusion
  - delayed cord clamping
  - unattended/uncontrolled or precipitous delivery

Symptoms and signs

- Commonly plethoric but asymptomatic
- Cardiorespiratory
  - respiratory distress
  - tachycardia
  - persistent pulmonary hypertension of the newborn
  - congestive cardiac failure
- CNS
  - lethargy, hypotonia within 6 hr
  - difficult arousal, irritability
  - jittery
  - easily startled
  - seizures
- GIT
  - poor feeding
  - vomiting
  - NEC
- Metabolic
  - hypoglycaemia
  - hypocalcaemia
  - jaundice
- Haematological
  - thrombocytopaenia
- Renal
  - renal failure
  - renal vein thrombosis

POLYCYTHAEMIA ● 2/2

INVESTIGATIONS

In all unwell babies and at-risk babies who look plethoric (as mentioned above)

- FBC/Hct
- If Hct >65%, repeat a free-flowing venous sample or obtain arterial Hct (capillary Hct sample unreliable)
- If polycythaemic, check blood glucose, serum calcium, serum bilirubin

IMMEDIATE TREATMENT

- Decisions regarding treatment to be made on the basis of venous Hct
- Ensure babies at risk have liberal fluid intake 1 day ahead of usual requirement (see **Intravenous fluid therapy** guideline)

Asymptomatic babies with Hct >70%

- Repeat venous Hct after 6 hr
- if still high, discuss with consultant

Symptomatic babies with Hct >65%

- Possible symptoms: fits and excessive jitteriness, with neurological signs and refractory hypoglycaemia

Treatment

- Dilutional/partial exchange transfusion. Discuss with consultant
- use of haemodilution for treatment of polycythaemia is not supported by evidence and treatment of asymptomatic babies is not recommended
- explain to parents the need for exchange transfusion and possible risks before performing partial exchange transfusion. Partial exchange transfusion increases risk of NEC
- use sodium chloride 0.9% (see **Exchange transfusion** guideline)
- Volume to be exchanged = 20 mL/kg
- Perform exchange via peripheral arterial and IV lines **or** via umbilical venous catheter
- Take 5–10 mL aliquots and complete procedure over 15–20 min

SUBSEQUENT MANAGEMENT

- Babies who required partial exchange transfusion require long-term neurodevelopmental follow-up
- Otherwise, follow-up will be dependent on background problem

POSITIONING ● 1/3

For comfort and development

- Poor positioning may cause:
  - discomfort
  - disturbed sleep
  - physiological instability
  - impaired cerebral blood flow
  - increased intracranial pressure
  - increased gastro-oesophageal reflux (GOR)
  - poor thermoregulation
  - compromised skin integrity
  - flattened elongated head shape and postural deformities
  - inability to interact socially
  - poor parental perception of baby
  - stress
  - increased desaturations, bradycardias and apnoeic episodes
- Positions described below aim to minimise these effects

Positions

- Consider for all, including ventilated babies. See also **Kangaroo care** guideline

Position	Use for	Method
Prone	• Respiratory compromise • GOR • Unsettled babies • Older babies to encourage physical development – active neck extension, head control and subsequent gross motor skills • Lifting • Reducing the frequency of bradycardia and desaturations in very preterm babies • Reducing the frequency of desaturations in preterm babies	• Tuck limbs with arms forward and hands near to face for self-calming • Provide head support • Place small, soft roll under baby from head to umbilicus to allow a rounded, flexed posture (prevents flattening of trunk and shoulder retraction – 'W' position) • Support with good boundaries to prevent excessive hip abduction ('frog' position) • Avoid neck hyperextension • **Always monitor a baby when in prone position. Give parents/carers information about FSID recommendations before discharge**
Supine	• Some surgical and medical conditions • Older babies ready for interaction • Intubated babies where midline head support necessary (e.g. for cooling) • Most difficult position for babies to work against gravity for self-calming and development of movement • Safest sleeping position for babies not monitored – promote supine sleeping and feet-foot position before discharge	• Provide supportive boundary to allow hands-to-face/mouth for self-calming and prevent shoulder retraction ('W' position) • Provide head support • Avoid excessive neck rotation (impairs cerebral blood flow) • If required, neck roll must be small and soft to avoid restricting cerebellar blood flow
Side-lying	• Most babies • Best position for self-regulation and calming behaviours • Left side-lying reduces GOR • Lifting • Use elevated side-lying position for preterm, hypotonic or babies with chronic lung disease or neurological impairment when learning to bottle feed • May be appropriate for other medical conditions where increased	• Provide back support. Gently curl back, flex hips and knees. Avoid excessive flexion which may impair respiration and digestion • Position with feet against boundary to facilitate foot bracing • Keep head in midline • Keep upper shoulder slightly flexed to prevent baby falling backwards • Support arms in midline, with hands close to face – use straps of nest/soft sheet. Give baby small soft toy/roll to 'cuddle' to support upper arm

	risk of aspiration	
Sitting	• Near term ready for more interaction/stimulation • GOR • Encourages midline position, chin tuck, eye/hand co-ordination	• Use reclining baby seat • Maintain midline position – use blanket rolls to prevent slumping, asymmetry and plagiocephaly • Keep hips in middle of seat • Place padding behind back (from shoulder level) to allow head to rest in line with body • Tuck rolls under shoulders to bring arms forward • Avoid over-stimulation. Do not place objects too close to baby's face
Car seats (information for parents)	• Small and preterm babies are at risk of breathing difficulties while travelling in car seats	• Fasten straps before tucking blankets around baby • Use inserts only if recommended/approved by car seat manufacturer • Advise parents to refer to the Lullaby Trust website (https://www.lullabytrust.org.uk/baby-safety/) before purchasing a car seat • Advise parents to keep time baby spends in car seat to a minimum and observe closely during journey

Comfort score

- Observational tool to assess positioning as a guide to promote comfort and minimise postural deformity

		Least comfortable							Most comfortable
1	**Aah! Factor**	Baby looks uncomfortable (include facial expression and colour) – you feel you want to do something about it	0	1	2	3	4	5	Baby looks relaxed, comfortable, cosy, content
2	**Head and trunk**	Trunk arched/rotated or curved **with** a) Head extended **or** b) Chin on chest **or** c) Head flat to side with twisted neck	0	1	2	3	4	5	Head and trunk in line, with head in midline or three-quarters toward side of head (neck not fully twisted)
3	**Arms**	Flaccid or stiff, and stretched out **or**: a) 'W' position with shoulders retracted (pushed back) **or** b) Twisted/trapped under body **or** between body and bedding **or** immobilised	0	1	2	3	4	5	All the following: a) Shoulders forward b) Arms flexed or relaxed c) Possible to reach mouth or face with ease
4	**Hands**	a) Fingers splayed **or** b) Hands tightly fisted **or** c) Immobilised or restricted by clothing	0	1	2	3	4	5	≥1 of the following: a) Hands relaxed, open, or fingers softly folded b) Hands together or clasped c) Touching head/face/ mouth/own body d) Holding/grasping onto something
5	**Legs**	a) Flaccid, with straight	0	1	2	3	4	5	In all positions:

	and feet	or 'frog-like' posture (abducted and externally rotated at hips) with feet pointing outwards **or** b) Stiff, straight legs with toes splayed or curled tight, and/or pushing hard on bedding, turning outwards							a) Flexed legs with feet touching each other, or resting against other leg **and** b) Able to reach boundary to brace feet In prone position, knees should be tucked under body, feet angled towards each other (not turning out)
6	**Arousal**	a) Agitated, jerky, jittery movements **and/or** b) Fussing or crying c) Unconscious	0	1	2	3	4	5	a) Sleeping restfully or quietly awake b) Minimal or smooth movement
	Total								(Max score = 30)

Reproduced with permission (Inga Warren, consultant occupational therapist, Winnicott Baby Unit)

POST HAEMORRHAGIC VENTRICULAR DILATATION ● 1/3

INTRODUCTION

- Incidence of intraventricular haemorrhage (IVH) has overall declined to 15–20% of preterm babies with birth weight <1500 g
- Post haemorrhagic ventricular dilation (PHVD) is a major complication of severe IVH
- nearly 10% of all babies with IVH, and 20% of babies with severe IVH, will develop progressive PHVD requiring surgical intervention to prevent parenchymal damage in the developing brain
- PHVD presents as:
- acute: evident within days as ballooning of the ventricles
- subacute/chronic: evident within weeks
- Discuss management of PHVD with neurosurgical team
- Current management: conservative or therapeutic lumbar punctures (LPs) or CSF tapping from temporising ventricular access device (VAD), with aim of reducing the pressure effect caused by progressive ventricular enlargement, and removing red cells and protein from CSF once standard threshold for treatment reached

RECOGNITION AND ASSESSMENT

Risk factors

- Prematurity
- Severe GMH-IVH with ventricular dilatation (>50% ventricular dilatation with ballooning of ventricle)
- Acute process due to impairment of CSF absorption and circulation associated with blood clots
- Subacute-chronic form with obliterative arachnoiditis in the posterior fossa

SIGNS

- Increase in lateral ventricular dimensions on serial cranial ultrasounds – measured as ventricular index (VI), and/or increase in anterior horn width (AHW) of the ventricle at the level of the 3rd ventricle in coronal views
- Rapid increase in occipitofrontal circumference (OFC)
- Symptoms of increased intracranial pressure (ICP) lag by 1–3 weeks and consist of:
- full fontanelle
- separated sutures
- apnoea
- poor feeding
- irritability
- increased/altered neurological tone
- seizures

MONITORING AND INVESTIGATIONS

Cranial ultrasound

- Perform twice weekly following large GMH-IVH to monitor evolution of PHVD
- Assess lateral ventricular size with 2 standard measurements taken at the level of the 3rd ventricle in the coronal view
- VI: distance between falx and lateral wall of anterior horn of lateral ventricle (plot on Levene's chart)
- AHW (to measure ballooning of ventricle)
  - AHW >4 mm indicative of enlarged ventricles in keeping with VI >97th centile + 4 mm
- Measure resistive index (RI) of anterior cerebral artery to assess raised ICP
- end diastolic velocity decreases as ICP increases, causing RI to increase >0.85
- RI >1.0 indicates impaired perfusion in absence of PDA
- Repeat cranial ultrasound scan after therapeutic LP to assess VI, with aim to reduce VI below threshold limit of treatment (<97th centile + 4 mm on Levene's chart)

Head circumference/OFC

- Measure OFC twice weekly **and** before and after intervention with LP
- Normal OFC growth:
- 26–32 weeks: 1 mm/day
- ≥33 weeks–term: 0.7 mm/day

- Head circumference growth accelerates with elevated CSF (OFC growth lags behind ventricular enlargement by 1–3 weeks)
- increase of >2 mm/day over 2 days, or 14 mm over 7 days, is excessive

Cerebral function monitoring (CFM) and EEG

- Use CFM to monitor for suspected seizures
- If there are seizures, confirm with full EEG
- Lack of normal background activity associated with poor outcome

MRI

- Before insertion of VP shunt
- Neurosurgeons may use MRI before insertion of VAD in selective cases

TREATMENT

- Threshold for intervention:
- VI >97th centile + 4 mm on Levene's chart for appropriate gestational age **and/or**
- OFC increase >4 mm over 2 days/>14 mm in 7 days **and/or**
- increase in AHW >4 mm
- Therapeutic LP to reduce CSF pressure through drainage of CSF
- before LP maintain:
  - platelet count >50
  - clotting profile in normal range
- Aseptic LP to remove ≥10 mL/kg CSF at rate of 1 mL/kg/min
- If rapid increase in OFC despite initial LP, repeat
- Do not exceed >15 mL/kg of CSF volume at one time
- removal of larger volumes of CSF faster than 1 mL/kg/min can result in apnoea, bradycardia and desaturation
- Send CSF for biochemical, microscopy and culture analysis each time LP performed
- Following therapeutic LP, repeat cranial ultrasound scan to assess VI; aim to reduce to below threshold limit
- Discuss with neurosurgical team before any intervention
- Refer to neurosurgical team for consideration of insertion of CSF reservoir/VAD if:
- LPs unsuccessful in draining CSF in 2 consecutive attempts
- non-communication between ventricles and spinal canal VIs remain above threshold for intervention **and/or**
- OFC continues to increase
- Consider ventricular tap under ultrasound guidance as a bridge to surgery for insertion of VAD
- avoid many ventricular taps – high risk of causing needle tract intra-parenchymal injury and infection
- If repeated prolonged tapping via VAD required to maintain normal head growth/ persistent rapid rise in OFC/baby remains symptomatic – discuss with neurosurgeon for consideration of VP shunts
- CSF protein to be <1.5 g m/L and weight to be >2 kg (in most cases)

SUBSEQUENT MANAGEMENT

- Monitor serum sodium levels – increased risk of hyponatraemia with repeated CSF drainage
- Maintain sodium >140 mmol/L; supplement intake as necessary
- If therapeutic tap from VAD >12–15 mL/kg/tap, replace CSF volumes with sodium chloride 0.9% IV fluid bolus to avoid hypovolaemia and decreased cerebral perfusion
- if CSF volumes <12 mL/kg/tap, and done at 1 mL/kg/min, fluid bolus not required unless baby haemodynamically unstable
- Treat seizures (see **Seizures** guideline)
- Refer to physiotherapy service

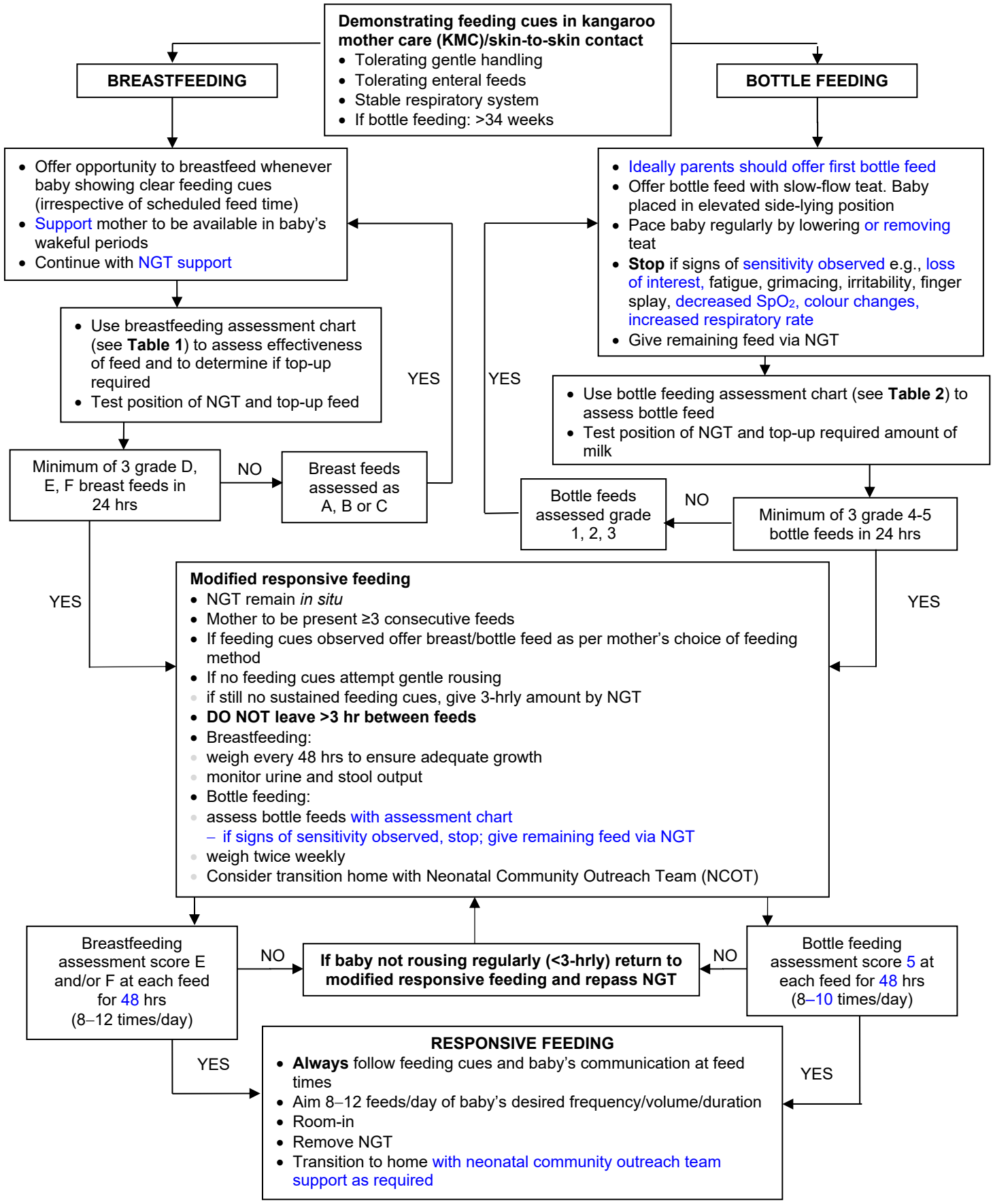
INFORMATION FOR PARENTS

- On diagnosis of PHVD, most senior clinician to counsel parents about diagnosis, management and prognosis

PROGNOSIS

- Marked cognitive impairment (mental developmental quotient <70) seen in approximately 45–60% of babies with PHVD, along with impaired motor outcomes
- Need for VP shunt worsens long-term neurodevelopmental outcomes

PROGRESSION TO SUCK FEEDING IN PRETERM BABIES ● 1/4


Demonstrating feeding cues in kangaroo mother care (KMC)/skin-to-skin contact
• Tolerating gentle handling
• Tolerating enteral feeds
• Stable respiratory system
• If bottle feeding: >34 weeks
BREASTFEEDING
BOTTLE FEEDING
• Offer opportunity to breastfeed whenever baby showing clear feeding cues (irrespective of scheduled feed time)
• Support mother to be available in baby's wakeful periods
• Continue with NGT support
• Use breastfeeding assessment chart (see Table 1) to assess effectiveness of feed and to determine if top-up required
• Test position of NGT and top-up feed
YES
Minimum of 3 grade D, E, F breast feeds in 24 hrs
NO
Breast feeds assessed as A, B or C
• Ideally parents should offer first bottle feed
• Offer bottle feed with slow-flow teat. Baby placed in elevated side-lying position
• Pace baby regularly by lowering or removing teat
• Stop if signs of sensitivity observed e.g., loss of interest, fatigue, grimacing, irritability, finger splay, decreased SpO2, colour changes, increased respiratory rate
• Give remaining feed via NGT
YES
• Use bottle feeding assessment chart (see Table 2) to assess bottle feed
• Test position of NGT and top-up required amount of milk
Minimum of 3 grade 4-5 bottle feeds in 24 hrs
NO
Bottle feeds assessed grade 1, 2, 3
YES
YES
Modified responsive feeding
• NGT remain in situ
• Mother to be present ≥3 consecutive feeds
• If feeding cues observed offer breast/bottle feed as per mother's choice of feeding method
• If no feeding cues attempt gentle rousing
• if still no sustained feeding cues, give 3-hrly amount by NGT
• DO NOT leave >3 hr between feeds
• Breastfeeding:
• weigh every 48 hrs to ensure adequate growth
• monitor urine and stool output
• Bottle feeding:
• assess bottle feeds with assessment chart
– if signs of sensitivity observed, stop; give remaining feed via NGT
• weigh twice weekly
• Consider transition home with Neonatal Community Outreach Team (NCOT)
Breastfeeding assessment score E and/or F at each feed for 48 hrs (8–12 times/day)
NO
If baby not rousing regularly (<3-hrly) return to modified responsive feeding and repass NGT
NO
Bottle feeding assessment score 5 at each feed for 48 hrs (8–10 times/day)
YES
YES
RESPONSIVE FEEDING
• Always follow feeding cues and baby's communication at feed times
• Aim 8–12 feeds/day of baby's desired frequency/volume/duration
• Room-in
• Remove NGT
• Transition to home with neonatal community outreach team support as required

4-hrly feeds are NOT appropriate for preterm or term babies – this is not a physiological feeding pattern, it can cause stress, fatigue, respiratory distress, reflux and aspiration, and may contribute to long-term sensory based feeding difficulties e.g. feeding aversions

PROGRESSION TO SUCK FEEDING IN PRETERM BABIES ● 2/4

Table 1: Breastfeeding assessment chart for babies receiving special/transitional care

Score	Category at 10 min	Action
A	• Offered breast: not interested, remained sleepy	• Full top-up (preferably EBM)
B	• Interested in feeding: licking and nuzzling, but does not latch	• Full top-up (preferably EBM)
C	• Latches, has few sucks then comes off breast • repeats pattern for several minutes/falls asleep within few minutes of latching	• Full top-up (preferably EBM)
D	• Latches, starts sucking and swallowing but: • sucking is shallow for most of feed (>2 suck/sec) • short sucking bursts • long pauses (mum feels need to encourage to restart sucking)	• Half–full top-up (preferably EBM) – depending on weight gain, milk supply and wet and dirty nappies • If receiving phototherapy/excessive weight loss – give full top-up
E	• Latches well • Rhythmic sucking and swallowing (see below) • Feed duration 5–10 min	• Half top-up (preferably EBM) • consider not topping up if mother is available for next feed • If score A–E at next feed: offer top-up feed as indicated above • If receiving phototherapy/excessive weight loss – give full top-up
F	• Effective latch and rhythmic sucking and swallowing (see below) • Duration 10–40 min/breast • >1 breast may be taken	• Second breast can be offered, but no top-up required provided: • wakes naturally to feed ≥8 times/day • expected number and colour of wet and dirty nappies • gaining weight (weight check every 48 hr) • milk supply increasing

Signs of effective breastfeeding

- Effective latch
- latches within few seconds of trying, with wide open mouth
- no nipple pain after 10–20 sec
- chin pressed against breast
- head tipped back slightly, nose lightly touching breast
- some areola seen above top lip, but not below bottom lip
- rounded cheeks (not sucked in)
- remains attached throughout feed
- nipple looks rounded (not pinched) at end of feed
- Rhythmic sucking and swallowing
- rapid sucks (≥2 sucks/sec) at first, slowing to regular bursts of rhythmic sucking
- deep jaw drops (1 suck/sec) before brief pause for most of feed
- Eyes open at start of feed
- Remains calm and relaxed as feed progresses
- Baby removes self from breast when no longer wants milk, and looks relaxed and sleepy

Table 2: Bottle feeding assessment chart for babies receiving special/transitional care

Score	Category best describes baby's response to bottle feed	Action
1	• Moves back to **OR** remains in a quiet and/or deep sleep with no feeding cues observed	• Give feed by NGT
2	• Latches to teat and begins to suck • sucking bursts are short with longer pauses to breathe **OR** • sucking bursts require very frequent pacing to help slow milk flow • baby shows signs of wanting to stop and/or falls asleep within first 5 min of feed, follow **Action**	• Stop feed • Give remaining feed by NGT
3	• Latches to teat and begins to suck • sucking bursts are short with longer pauses to breathe **OR** • sucking bursts need regular pacing to help slow milk flow • baby shows signs of wanting to stop within 15–20 min of the bottle feed – pause feed and watch baby – if baby shows no more feeding cues, follow **Action**	
4	• Latches to teat and begins to suck • sucking bursts become longer with shorter pauses to breathe **OR** • sucking bursts need some pacing to help slow milk flow • baby shows signs of wanting to stop within 15–20 min of feed. Pause feed and watch baby – if baby shows no more feeding cues, follow **Action**	
5	• Latches to teat and begins to suck • regular bursts of rhythmical sucking, swallowing, and breathing together with occasional pacing to help slow milk flow • baby is calm and awake or moves to a quiet sleep when they have finished feed	• No feed by NGT

Supportive strategies to prepare for bottle feeding:

- Skin-to-skin contact
- Positive touch
- Mouth care with EBM
- Non-nutritive sucking
- Held in skin-to-skin contact during NGT feeds

Early feeding cues:

- Stirring
- Mouth opening/tongue moving
- Turning head/rooting
- Stretching
- Bringing hands to mouth

Signs of sensitivity (pause and stop cues) during bottle feed:

- Finger splay
- Grimacing
- Crying
- Yawning
- Hiccoughing
- Arching body
- Turning head away/loss of interest
- Tires and/or moves to a quiet sleep
- Dribbling milk from mouth
- Colour change to face, lips, nose/fingertips

PROGRESSION TO SUCK FEEDING IN PRETERM BABIES ● 4/4

Supportive interventions during bottle feed:

- Cue-based responsive feeding
- Elevated side-lying feeding position
- Slow flow teat
- Pacing

Babies receiving non-invasive respiratory support in NNU

- Due to developmental, physiological, anatomical, respiratory and/or neurological difficulties, transition to suck feeding may be more complex – possible impact on baby's feeding and swallowing
- Caution recommended as lack of guidance and varied opinion in literature
- Request speech and language therapy assessment, with input from parents/carers/MDT

PROSTAGLANDIN INFUSION ● 1/2

INDICATIONS

To achieve and/or to maintain patency of ductus arteriosus in critical congenital heart defects with duct dependent systemic or pulmonary circulations

DOSAGE

- Ranges from 5–50 nanogram/kg/min (higher doses may be used on recommendation of a tertiary specialist)
- Starting dose depends upon time of diagnosis and condition of baby:
- antenatal diagnosis of duct dependent lesion – start at 5 nanogram/kg/min
- well but cyanosed baby with normal pH – start at 5–10 nanogram/kg/min
- well baby with poorly palpable pulses but normal pH – start at 10–15 nanogram/kg/min
- acidotic or unwell baby with suspected duct dependent lesion – start at 50 nanogram/kg/min
- If not achieving desired response at the lower dose – increase dose rapidly

Desired response

- Suspected left-sided obstruction:
- aim for palpable pulses, normal pH and lactate <2 mmol/L
- Suspected right-sided obstruction:
- aim for SpO_2 75–85% and lactate <2 mmol/L
- Suspected or known transposition of the great arteries (TGA):
- aim for SpO_2 >75% and lactate <2 mmol/L
- urgently liaise with neonatal consultant, cardiologist and KIDS NTS team
- monitor for side effects

PREPARATIONS

Dinoprostone infusion

- **Dinoprostone (prostaglandin E2) is the recommended prostaglandin***
- make a solution of 500 microgram in 500 mL by adding 0.5 mL of dinoprostone 1 mg in 1 mL to a 500 mL bag of suitable diluent (glucose 5% , or sodium chloride 0.9%)
- transfer 50 mL of this solution into a 50 mL Luer lock syringe and label
- discard the 500 mL bag immediately into clinical waste – single patient and single dose use only
- infusion rate: 0.3 mL/kg/hr = 5 nanogram/kg/min delivered continuously (short half-life)
- **Stability:**
- syringe stable for 24 hr, after which fresh solution must be made
- **Administration:**
- infuse dinoprostone via separate line
- ensure 2 working points of IV access at all times
- infusions can be given via long line, umbilical venous catheter or peripheral venous cannula
- extravasation can cause necrosis – use central access if available
- **Flush:**
- sodium chloride 0.9% at same rate as infusion

*If dinoprostone IV not available, use alprostadil (prostaglandin E_1) IV as alternative (see **Neonatal Formulary**)

Oral dinoprostone (see *Neonatal Formulary*)

- Used temporarily on very rare occasions when unable to get intravenous access despite appropriate escalation
- Discuss with cardiac centre
- Use dinoprostone injection orally
- May not be as effective as prostaglandin IV

SIDE EFFECTS

Common

- Apnoea – tends to occur in first hour after starting prostaglandin or when dose increased. Consider intubation and ventilation if unwell or has recurrent episodes of apnoea, but do not reduce infusion dose (see **Intubation** guideline)
- Hypotension – due to systemic vasodilatation. Consider sodium chloride 0.9% 10 mL/kg bolus

- Fever
- Tachycardia
- Hypoglycaemia

Uncommon

- Hypothermia
- Bradycardia
- Convulsions
- Cardiac arrest
- Diarrhoea
- Disseminated intravascular coagulation (DIC)
- Gastric outlet obstruction
- Cortical hyperostosis and gastric hyperplasia (on prolonged use)

MONITOR

- Heart rate
- Blood pressure
- Respiratory rate
- Temperature
- Oxygen saturations
- Blood gases
- Blood glucose and lactate

TRANSFER OF BABY RECEIVING PROSTAGLANDIN INFUSION

- Contact local retrieval team for transport of baby to cardiac centre (e.g. for Birmingham Children's Hospital – contact KIDS NTS team on 0300 200 1100)
- Keep baby nil-by-mouth for transfer
- In a well baby on prostaglandin ≤10 nanogram/kg/min, risk of apnoea is low

PULMONARY HAEMORRHAGE ● 1/2

Pulmonary haemorrhage can be life threatening and associated with high mortality. Inform on-call consultant at the earliest opportunity

RECOGNITION AND ASSESSMENT

Definition

- Acute onset of bleeding from trachea or ETT or from the larynx and mouth in a non-intubated baby associated with cardiorespiratory deterioration and changes on chest X-ray
- Significant pulmonary haemorrhage is most likely to represent haemorrhagic pulmonary oedema. Differentiate from minor traumatic haemorrhage following endotracheal suction

Risk factors

- Prematurity (higher risk if <32 weeks' gestation)
- Respiratory distress syndrome (RDS)
- Large patent ductus arteriosus (PDA)
- Excessive use of volume (>20 mL/kg) in first 24–48 hr in babies ≤28 weeks' gestation
- Coagulopathy
- Early onset sepsis
- IUGR
- Grade 3 hypoxic ischaemic encephalopathy (HIE)

Signs

- Apnoeas, gasping respirations, desaturations
- Tachycardia >160 bpm, bradycardia, hypotension, shock, PDA, signs of heart failure
- Widespread crepitations, reduced air entry
- Pink/red frothy expectorate, or frank blood from oropharynx or ETT if intubated

Investigations

- Blood gas (expect hypoxia and hypercapnia with mixed acidosis)
- FBC, clotting
- Chest X-ray (usually shows classic white-out with only air bronchogram visible but may be less striking and resemble RDS)

IMMEDIATE TREATMENT

- Basic resuscitation, ABC

Respiratory

- Intubate and ventilate
- if already intubated do not remove ETT unless blocked – may be very difficult to reintubate
- Sedate and give muscle relaxant
- Increase PEEP to 6–8 cm to control haemorrhage by tamponading pulmonary capillaries
- PIP and tidal volumes to be guided by chest expansion and blood gases
- Long inspiratory times (0.5 sec may be needed)
- Cautious endotracheal suction of haemorrhagic fluid (try to avoid but consider in extreme cases to reduce risk of ETT blockage)
- Ensure adequate humidification
- Chest physiotherapy contraindicated until active bleeding stopped and platelets >50 [see **Airway clearance (intubated babies)** guideline]
- Establish arterial access
- If requiring high PIP or persistent hypoxia and respiratory acidosis, consider HFOV

Fluid management

- If hypovolaemic, restore circulating volume over 30 min with 10 mL/kg sodium chloride 0.9% or Group O RhD negative packed cells if crystalloid bolus already given. Beware of overloading (added volume can be detrimental to LV failure)
- If not hypovolaemic and evidence of LV failure, give furosemide 1 mg/kg IV
- Correct acidosis (see **Neonatal Formulary**)
- If PDA present, restrict fluids to 60–80% in acute phase

- Further blood transfusion, vitamin K administration and FFP to be guided by Hb concentration, PT and APTT (see **Transfusion of red blood cells** and **Coagulopathy** guidelines). Coagulopathy is not usually seen before pulmonary haemorrhage but DIC can occur afterwards

Hypotension/cardiac dysfunction

- If still hypotensive or evidence of cardiac dysfunction after fluid resuscitation, treat hypotension with inotropes (see **Hypotension** guideline)

Infection

- Request septic screen and start antibiotics

SUBSEQUENT MANAGEMENT

Once baby stable

- Update parents
- Document event in case notes
- Consider single extra dose of surfactant in babies with severe hypoxaemia or oxygenation index (OI) >20

$$OI = \frac{\text{mean airway pressure (cm } H_2O) \times \text{\% oxygen}}{\text{postductal } PaO_2 \text{ (kPa)} \times 7.5}$$

- If PDA suspected, arrange echocardiogram (see **Patent ductus arteriosus** guideline)
- Perform cranial ultrasound scan to exclude intracranial haemorrhage as this is often associated with pulmonary haemorrhage and may influence management (see **Cranial ultrasound scans** guideline)

PULMONARY HYPERTENSION:
Acute pulmonary hypertension of the newborn (aPHN) ● 1/4

RECOGNITION AND ASSESSMENT

Definition

- Severe hypoxaemia due to failure of normal postnatal drop in pulmonary vascular resistance
- Can be primary (idiopathic) or secondary

Idiopathic persistent pulmonary hypertension of newborn (PPHN)

- Degree of hypoxia may be disproportionate to degree of hypercapnia
- no clear cause identified, but may be secondary to maternal drugs e.g. non-steroidal anti-inflammatory drugs or SSRIs
- Associated with polycythaemia

Secondary

- May be associated with:
- parenchymal lung disease e.g. meconium aspiration (MAS), surfactant deficiency, pneumonia/sepsis
- structural abnormalities: pulmonary hypoplasia, congenital diaphragmatic hernia (CDH), A-V malformations, congenital cystic adenomatoid malformation
- perinatal asphyxia or severe anaemia
- Rare causes: alveolar capillary dysplasia, surfactant protein B deficiency

CLINICAL FEATURES

Usually present in first 12 hr of life

- Hypoxia with/without hypercapnia, SpO_2 >10% difference in preductal (right hand) and postductal saturations (feet) (preductal saturations > postductal saturations)
- Mimics cyanotic heart disease
- CVS: tricuspid regurgitant murmur, right ventricular heave, loud second heart sound with/without systemic hypotension
- Idiopathic PPHN: minimal or no respiratory distress
- Secondary aPHN: moderate to significant respiratory distress

INVESTIGATIONS

- Blood gas shows hypoxaemia with rising oxygenation index
- Chest X-ray: variable findings depending on underling diagnosis (black lungs with normal or minimal changes in idiopathic PPHN)
- Echocardiogram (although not mandatory for initial diagnosis and management) is useful:
- to exclude cyanotic heart disease
- to assess pulmonary pressure
- to evaluate right and or left ventricular dysfunction
- Echocardiographic signs of aPHN in presence of normal cardiac anatomy:
- significant tricuspid regurgitation (TR) (may not always be present in right heart dysfunction)
- dilatation of right side of heart and/or hypertrophy of right ventricle
- right-to-left shunting across PFO and/or PDA
- pulmonary regurgitation
- bowing of interventricular septum to the left
- relatively small left ventricle (though apex forming)
- Pulmonary pressure is estimated from echocardiogram using: TR (systolic pulmonary pressure = 4 x $(VmaxTR)^2$ + usual right atrial pressure of 5 mmHg)

MANAGEMENT

- If suspicion of duct dependent congenital heart disease, start prostaglandin infusion IV (see **Prostaglandin infusion** guideline)
- Once aPHN suspected involve consultant neonatologist immediately
- Aims of management are to:
- decrease pulmonary vascular resistance
- maintain normal systemic blood pressure and end-organ perfusion
- treat underlying condition, if known

PULMONARY HYPERTENSION:
Acute pulmonary hypertension of the newborn (aPHN) ● 2/4

General measures

- Minimal handling and noise
- Secure arterial and central venous access, (see **Arterial line insertion** guideline or **Umbilical artery catheterisation and removal** and **Umbilical venous catheterisation and removal** guidelines)
- Maintain normal temperature, biochemistry and fluid balance
- Keep ionised calcium >1 mmol/L and Mg ≥1 mmol/L
- Keep Hb ≥120 g/L
- Give antibiotics (infection is difficult to exclude at onset of disease process) (see **Infection in first 72 hours of life** guideline)
- Surfactant therapy may be beneficial in parenchymal lung diseases, e.g. MAS, pneumonia, surfactant deficient lung disease – discuss with consultant
- Use sedation – may use muscle relaxation in babies with high ventilatory and oxygen requirements and/or ventilator asynchrony
- Refer babies with aPHN requiring iNO to NICU for ongoing management

Ventilation and oxygenation

- Aim for disease specific ventilatory strategies:
  - lung recruitment in parenchymal lung disease
  - discuss with consultant regarding surfactant therapy
  - in black lung PPHN and CDH aim for gentle ventilation
- Commence with conventional ventilation (targeted tidal volume)
- High frequency oscillatory ventilation (HFOV) may be needed if requiring high pressures to deliver the set tidal volume [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]
- Aim for preductal SpO_2 91–95% kPa. Do not attempt to reduce pre and postductal saturation difference as long as postductal SpO_2 >70%
- Avoid intermittent desaturations (preductal) <85% or preductal SpO_2 >97%
- Aim for preductal PaO_2 7.3–10.6 (if right radial arterial line) (tolerable hypoxaemia)
- Monitor oxygenation index (OI)

$$OI = \frac{\text{mean airway pressure (cm } H_2O) \times \text{\% oxygen}}{\text{postductal } PaO_2 \text{ (kPa)} \times 7.5}$$

- If OI not available, consider oxygen saturation index (OSI)

$$OSI = MAP \times FiO2 \times SpO_2/100$$
$$OI = 0.0745 + (1.783 \times OSI)$$

- If umbilical arterial line OI will be higher as it is postductal OI and targeting lower postductal saturations
- Monitor OI trends
- Aim for $PaCO_2$ 6–8 kPa, avoid hypocapnia

Considerations for aPHN presentation in local neonatal unit (LNU)/special care unit (SCU)

- Refer to KIDS NTS for transfer to NICU and possible need for nitric oxide therapy, when:
  - FiO_2 >0.5 and all reversible factors have been addressed, e.g. surfactant deficiency/displacement or obstruction of ETT/pneumothorax/equipment failure/adequate ventilation (PiP ≤26 and mean airway pressure ≤16)

Pulmonary vasodilatation

- Use inhaled nitric oxide (NO) as a selective pulmonary vasodilator (see **Nitric oxide** guideline)
- Escalate to consultant and consider other pulmonary vasodilators (sildenafil, magnesium sulphate) while doing extracorporeal life support (ECLS) referral

Circulatory management

- Early echocardiogram recommended
- Aim for normal gestation specific blood pressure (see **Tables** for normal values)
- Avoid supraphysiological blood pressure
- If hypotensive, one bolus of sodium chloride 10 mL/kg over 20–30 min

PULMONARY HYPERTENSION: Acute pulmonary hypertension of the newborn (aPHN) ● 3/4

- If low pulse pressure (± LV dysfunction on echo), start beta dose adrenaline, if no adequate response add dobutamine
- If normal pulse pressure (± LV dysfunction on echo), start adrenaline (0.05–0.2 microgram/kg/min) and noradrenaline base (0.05–0.4 microgram/kg/min). If inadequate response, add dobutamine (5–10 microgram/kg/min)
- If hypotension with high pulse pressure (normal LV function), use vasopressin **and/or** noradrenaline
- Add prostin to support systemic circulation
- If normal blood pressure (RV dysfunctions), add milrinone – may need to add noradrenaline as milrinone may cause systemic vasodilatation
- If PDA restrictive or closing, add prostin to off load RV
- If no response to first-line inotrope, add hydrocortisone
- Monitor for side effects of treatment e.g. tachycardia, rising lactates
- Monitor urine output and UEs 4–6 hrly with vasopressin
- Avoid vasopressin in LV dysfunction

Severe and resistant aPHN not responding to conventional management in NICU

- Not responding or rising OI despite escalation of ventilation and iNO therapy
- Recurrent pulmonary hypertensive episodes
- Hypotensive despite inotropes or worsening side effects of inotropic therapy
- No significant progression in 2–3 days
- Discuss with KIDS NTS team (see **Transport and retrieval** guideline) and conference call with ECLS centre

Criteria for ECLS

- Baby born ≥34 weeks or ≥2 kg with aPHN
- If OI remains >25 despite starting above therapies — conference call with KIDS NTS and PICU to discuss management and ECLS criteria
- Reversible lung disease
- No lethal congenital malformation

Exclusion criteria (if in doubt, discuss with ECLS team)

- Major intracranial haemorrhage
- Lethal congenital or chromosomal anomalies
- Severe encephalopathy
- Major cardiac malformation

A baby accepted for transfer to ECLS centre will be retrieved by ECLS or PICU team

- ECLS centre will need:
  - cranial ultrasound scan
  - maternal blood for group and crossmatching (check with ECLS centre)
- Outreach ECLS
- ECLS team may decide to start outreach ECLS in NNU before transfer to ECLS unit. Check with ECLS team regarding diathermy unit and number of packed cell units needed for procedure

Referral for ECLS

- For West Midlands contact KIDS NTS team on 0300 200 1100
- KIDS NTS will liaise with ECLS centres to find a cot and/or give advice

PULMONARY HYPERTENSION:
Acute pulmonary hypertension of the newborn (aPHN) ● 4/4

Flowchart: Management of aPHN

Clinical evidence of aPHN OI >20
- Echocardiography to exclude cyanotic heart disease

Assessment
- BP, HR, CRT, urinary output and continuous pre- and post-ductal saturations
- BP (systolic, diastolic and mean) target >3rd centile for gestational age

Monitoring
- BP every 15 min until stable, then hourly
- invasive BP recommended
- Monitor blood gas, lactate as clinically indicated
- If vasopressin used, U&Es and urinary output 4–6 hrly

Full response to iNO
- ↑SpO_2 >20, ↑PaO_2 >3, ↓FiO2 >0.2 on the same ventilator settings in 60 min

Partial response
- ↑SpO_2 10–20%, ↑PaO_2 2–3, ↓FiO2 ≥0.1

Optimise lung recruitment, surfactant, Ca, Mg, sedation

Commence iNO at 20 ppm

Wean iNO as per guidelines

No/partial response

- If OI not available, consider oxygen saturation index
  OSI = MAP x FiO_2 x SpO_2/100
  [OI = 0.0745 + (1.783 x OSI)]

- Optimise ventilatory settings
- Early echo recommended

One fluid bolus 10 mL/kg over 20–30 min

↓ BP (narrow pulse pressure)
+/- echo: LV/biventricular dysfunction
- Beta dose adrenaline 0.05 microgram/kg/min Increase by 0.01–0.02 microgram/kg/min every 30–60 min (maximum 0.2 microgram/kg/min)
  or/add
- Dobutamine: 5 microgram/kg/min, increase by 5 microgram/kg/min every 30 min
  and
- If PDA closing start Prostin to support system circulation
- If no response to 1st line inotrope, add hydrocortisone 2.5 mg/kg 6-hrly

Caution: avoid vasopressin in LV dysfunction

↓ BP (normal pulse pressure)
+/- echo: LV/biventricular dysfunction
- Beta dose adrenaline 0.05 microgram/kg/min Increase by 0.01–0.02 microgram/kg/min every 30–60 min (maximum 0.2 microgram/kg/min)
  or/add
- Dobutamine: 5 microgram/kg/min, increase by 5 microgram/kg/min every 30 min
  and
- Noradrenaline base 0.05 microgram/kg/min increase by 0.05 microgram/kg/min every 30 min
  and
- If PDA closing start Prostin to support system circulation
- If no response to 1st line inotrope, add hydrocortisone 2.5 mg/kg 6-hrly

↓ BP (increased pulse pressure)
+/- echo: good biventricular function or only RV dysfunction, normal both COP
- Vasopressin 0.0003 units/kg/min, increased by 0.0001–0.0003 units/kg/min every 30 min
  or/add
- Noradrenaline base 0.05 microgram/kg/min increase by 0.05 microgram/kg/min every 30 min

RV dysfunction and low RV output, good LV function
- If BP normal: milrinone 0.25 microgram/kg/min, may increase up to 0.75 microgram/kg/min, no loading dose
- If hypotension: adrenaline 0.05 microgram/kg/min. Increase by 0.01-0.02 microgram/kg/min every 30–60 min (maximum 0.2 microgram/kg/min)
  or
- Dobutamine: 5 microgram/kg/min, increase by 5 microgram/kg/min every 30 min

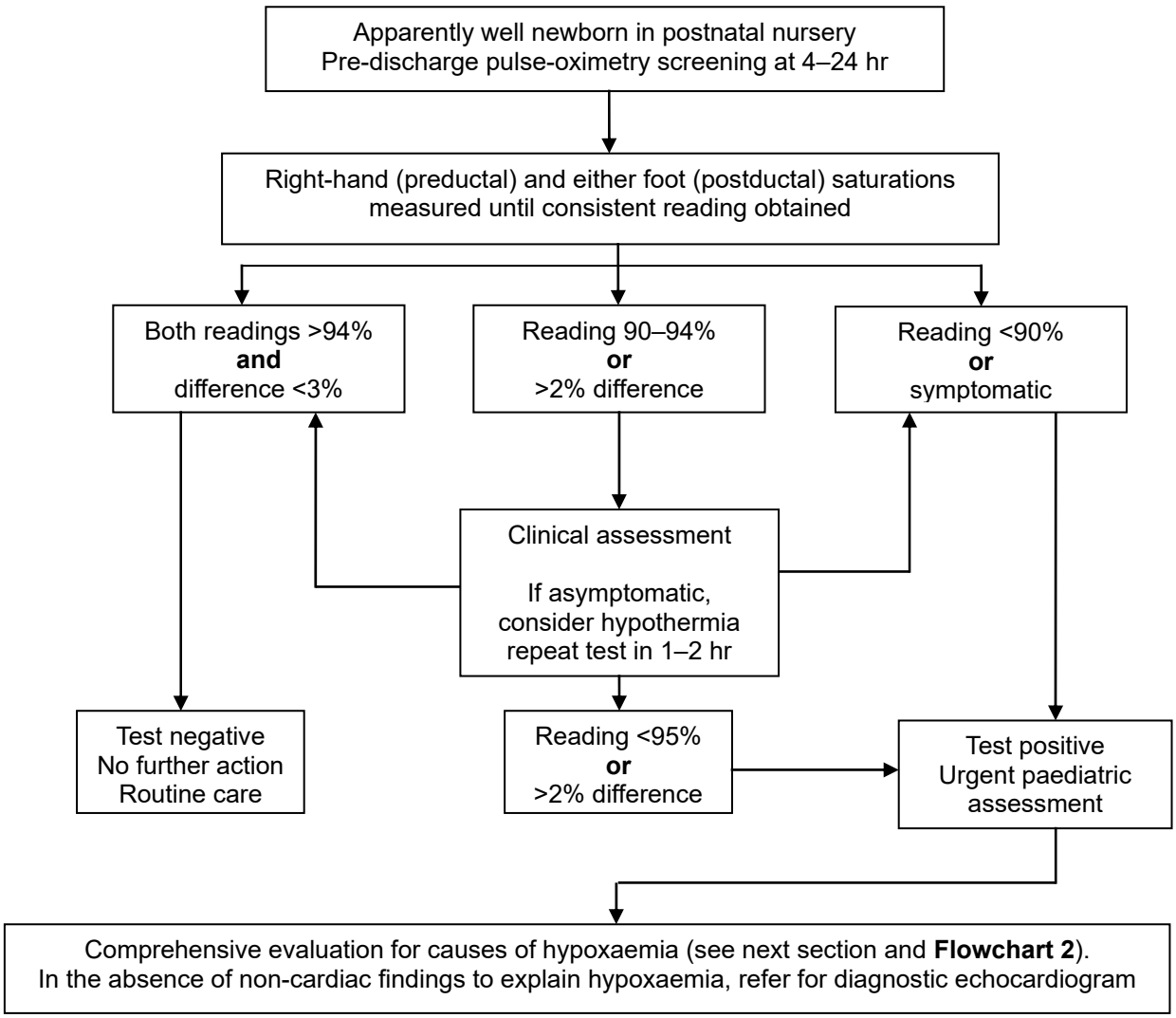
- If no response to inotropes, pressors, pulmonary vasodilators and OI >25, discuss with ECLS centre
- Caution with milrinone, do not use unless blood pressure robust. Contraindication renal impairment

PULSE-OXIMETRY (UNIVERSAL) SCREENING ● 1/3

INTRODUCTION

- Used in most UK maternity units following results and recommendation of pulse-oximetry study to detect critical congenital heart defects for babies born ≥34 weeks' gestation in addition to, but usually before clinical examination
- serious non-cardiac conditions may also be identified

Flowchart 1: Pulse-oximetry screening test


Apparently well newborn in postnatal nursery
Pre-discharge pulse-oximetry screening at 4–24 hr
Right-hand (preductal) and either foot (postductal) saturations measured until consistent reading obtained
Both readings >94% and difference <3%
Reading 90–94% or >2% difference
Reading <90% or symptomatic
Clinical assessment
If asymptomatic, consider hypothermia repeat test in 1–2 hr
Test negative No further action Routine care
Reading <95% or >2% difference
Test positive Urgent paediatric assessment
Comprehensive evaluation for causes of hypoxaemia (see next section and Flowchart 2).
In the absence of non-cardiac findings to explain hypoxaemia, refer for diagnostic echocardiogram

POSITIVE PULSE-OXIMETRY SCREEN (ABNORMAL TEST)

Initial assessment of test-positive baby

Assess cardiac and respiratory systems

- Is baby symptomatic?
- quiet, less responsive
- temperature instability
- tachypnoea with respiratory rate ≥60 min
- respiratory distress
- grunting respirations
- nasal flaring
- chest wall recession
- apnoea

Examination

- Abnormal breath sounds
- Heart murmur

- Weak or absent femoral pulse
- Response to oxygen therapy

History
- Previous cardiac defect or congenital infection?
- Suspicion of congenital abnormality on antenatal scan?
- Maternal illness during pregnancy, including diabetes?
- Drug ingestion during pregnancy (anticonvulsants)?
- PROM
- Positive maternal culture
- Maternal fever or raised inflammatory markers
- Foul-smelling liquor
- Mode of delivery
- Need for resuscitation (Apgar score)

MANAGEMENT OF TEST-POSITIVE BABY

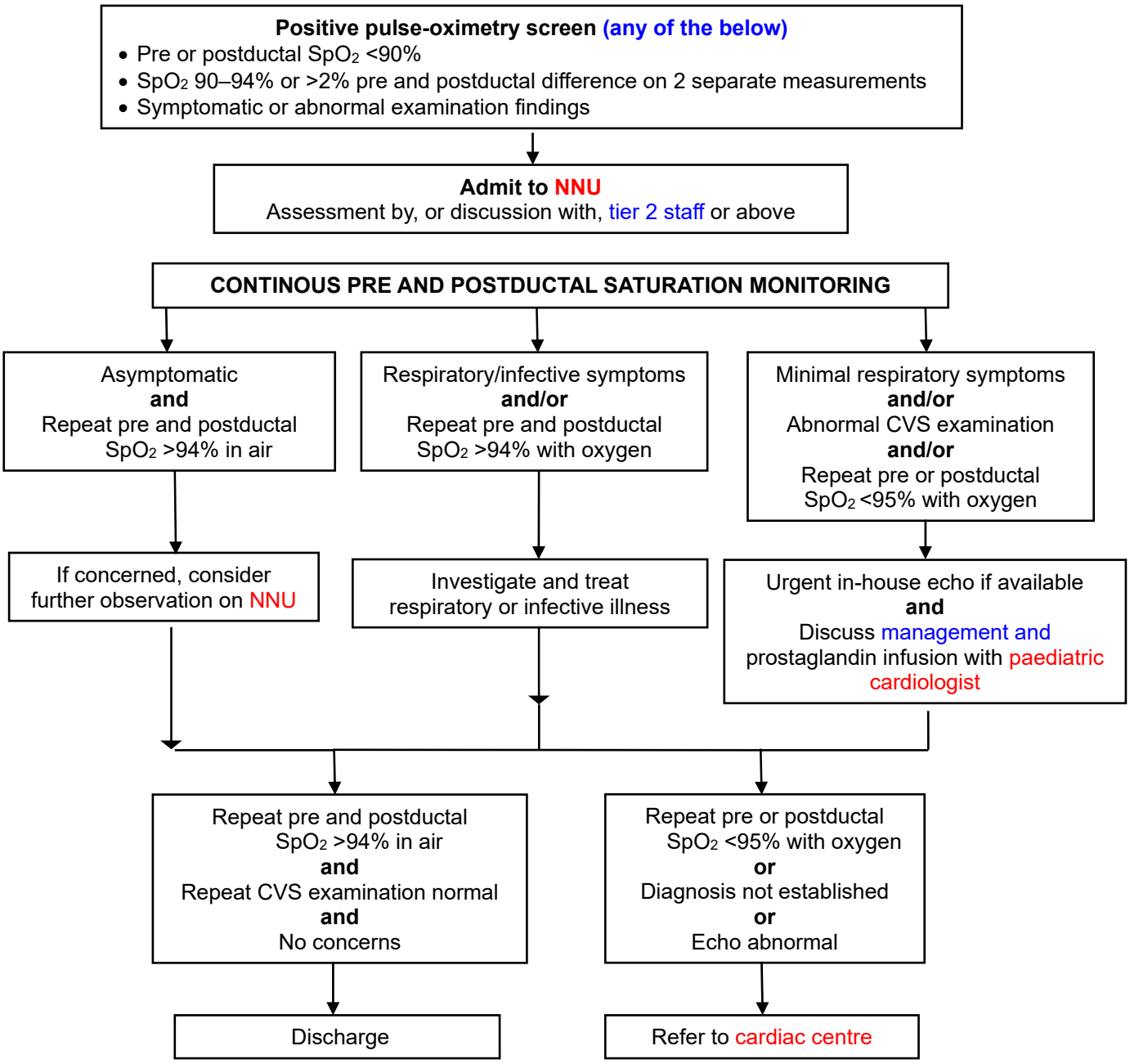
Any test-positive baby
- See **Flowchart 2**
- Seen by appropriately trained paediatric staff
- Seek advice from paediatric/tier 2 staff or above

Admission
- Admit to NNU for assessment if:
  - abnormal examination findings or
  - pulse-oximetry screening positive on 3 occasions (see **Flowchart 2**)

Investigations
- If respiratory/infective condition suspected from history/examination and saturations improve with oxygen
  - FBC/CRP/blood culture/chest X-ray as appropriate

Echocardiogram
- Indicated if any of the following:
  - CVS examination abnormal
  - no respiratory signs
  - no response to oxygen
  - low saturations persist
  - no satisfactory explanation
- If echo unavailable and strongly suspect duct dependent lesion, contact consultant regarding prostaglandin E_2 infusion/paediatric cardiology input (see **Congenital heart disease** and **Prostaglandin infusion** guideline)

Flowchart 2: Positive pulse-oximetry screen (abnormal test)


Positive pulse-oximetry screen (any of the below)
• Pre or postductal SpO2 <90%
• SpO2 90–94% or >2% pre and postductal difference on 2 separate measurements
• Symptomatic or abnormal examination findings
Admit to NNU
Assessment by, or discussion with, tier 2 staff or above
CONTINOUS PRE AND POSTDUCTAL SATURATION MONITORING
Asymptomatic
and
Repeat pre and postductal SpO2 >94% in air
Respiratory/infective symptoms
and/or
Repeat pre and postductal SpO2 >94% with oxygen
Minimal respiratory symptoms
and/or
Abnormal CVS examination
and/or
Repeat pre or postductal SpO2 <95% with oxygen
If concerned, consider further observation on NNU
Investigate and treat respiratory or infective illness
Urgent in-house echo if available
and
Discuss management and prostaglandin infusion with paediatric cardiologist
Repeat pre and postductal SpO2 >94% in air
and
Repeat CVS examination normal
and
No concerns
Repeat pre or postductal SpO2 <95% with oxygen
or
Diagnosis not established
or
Echo abnormal
Discharge
Refer to cardiac centre

RECTAL WASHOUT USING SYRINGE METHOD ● 1/2

INDICATIONS
- Suspected or confirmed Hirschsprung's disease
- Suspected meconium plugs

BENEFITS
- Bowel decompression
- Establishment of feeding
- Weight gain
- Reduced risk of colitis

CONTRAINDICATIONS
- Rectal biopsies taken in preceding 24 hr
- Rectal bleeding (relative contraindication)
- Severe anal stenosis
- Anus not clearly identified
- Known surgical patient (without discussion with surgical team)

ADVERSE REACTIONS
- Bleeding from anus or rectum
- Perforation of bowel (this is very rare)
- Electrolyte imbalance if inappropriate fluid used or retained
- Vomiting
- Hypothermia
- Distress to baby and parent

Consent
- Explain procedure to parents/carer and obtain verbal consent

Equipment
- Tube size 6–10 Fr
- Lubricating gel (if catheter not lubricated)
- Bladder tip syringe **no smaller than 60 mL**
- Rectal washout solution (sodium chloride 0.9%) warmed to room temperature
- Plastic apron
- Gloves
- Protective sheet
- Receptacle to collect effluent
- Container for clean rectal washout solution
- Blanket to wrap baby

Preparation
- Place all equipment at cot side
- Sedation is not necessary
- Second person to comfort baby using dummy and breast milk/sucrose [see **Non-nutritive sucking (NNS)** guideline]
- Wash hands, put on gloves and apron
- Position baby supine with legs raised
- Keep baby warm

PROCEDURE
- Inspect and palpate abdomen – note distension or presence of lumps
- Draw up sodium chloride 0.9% 60 mL into syringe and keep on one side
- Insert lubricated catheter into rectum [up to approximately 10 cm (in a term baby) or until resistance felt] noting any flatus or faecal fluid drained

RECTAL WASHOUT USING SYRINGE METHOD ● 2/2

- Massage abdomen in a clockwise direction to release flatus
- Attach syringe containing sodium chloride to tube in rectum and gently instil fluid:

Weight <2 kg	5–10 mL
Weight ≥2 kg	20 mL

- Disconnect syringe from tube and drain effluent into receptacle
- Repeat procedure until drained solution becomes clearer, up to a maximum of 3 times
- If solution does not drain out, manipulate tube in and out and massage abdomen
- If no faeces are passed or all the solution is retained, seek medical help
- Re-examine abdomen and note any differences
- Wash, dress and comfort baby

Preparation for discharge

- For discharge, baby should require ≤2 rectal washouts a day
- Refer to and order equipment via colorectal nurses (bwc.colorectalnurses@nhs.net) who will arrange follow-up
- Ward will supply 14 days' equipment
- Discharge letter for GP detailing rectal washout solution required
- Ensure parents competent to perform rectal washout and can describe signs of colitis
- complete rectal washout parent competency sheet if available locally

RE-CYCLING OF STOMA LOSSES VIA A MUCUS FISTULA ● 1/2

INDICATIONS
- Stoma output >30 mL/kg/day term baby (>20 mL/kg/day for preterm baby)
- Discrepancy in proximal and distal bowel calibre
- Inability to absorb increasing enteral feeds
- Failure to thrive
- Developing cholestasis

BENEFITS
- Maximise nutrition for sustained weight gain and decrease in parenteral nutrition
- Stimulation of gut hormones and enzymes
- Increases absorption of water, electrolytes and nutrients by utilising distal bowel
- Digestive tract matures and increases in length and diameter with use
- Adaptation is driven by enteral feed in distal bowel
- Preparation of distal bowel for closure
- Baby can, in some circumstances, be managed at home

CONTRAINDICATIONS
- Diseased or compromised distal bowel
- Rectal bleeding (not absolute but discuss with surgical team)
- Anal stenosis or imperforate anus
- Signs of systemic infection
- Effluent too thick to infuse

ADVERSE REACTIONS
- Bleeding from distal stoma
- Perforation of bowel by catheter (rare)
- Leakage of stoma effluent onto peri-stomal skin may result in excoriation of the skin
- Distress to baby and parent
- Sepsis due to translocation

Before commencing
- Discuss with surgical team to confirm
- they agree with procedure
- whether distal contrast study is required before re-cycling

Consent
- Explain procedure and potential adverse reactions to parents and obtain verbal consent

Equipment
- Tube (enteral or Foley catheter) size 6 or 8 Fr
- Lubricating gel (if catheter not lubricated)
- Enteral syringe (60 mL)
- Stoma pot to collect stoma effluent
- Extension tubing
- Syringe pump (enteral pump if available)
- Plastic apron and gloves
- Tape and dressing

Documentation
- Record name of surgeon requesting procedure in baby's notes (when commencing)
- Record condition of peri-stomal skin pre-procedure

Preparation
- Place all necessary equipment at cot side
- Wash hands and put on gloves and apron
- Position baby in supine position and keep warm

PROCEDURE
- Confirm which visible stoma is the mucus fistula – operation note or surgical team

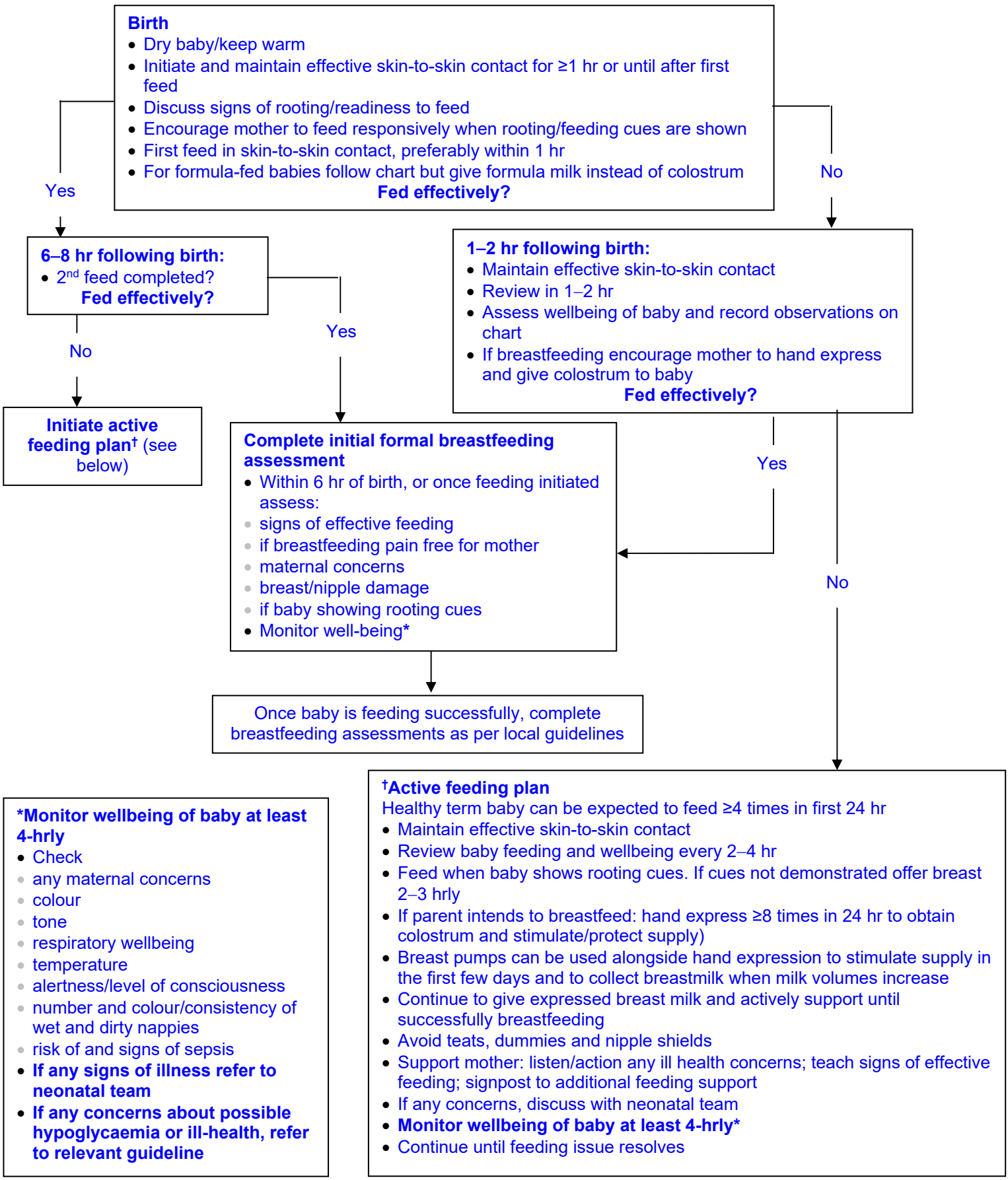
RE-CYCLING OF STOMA LOSSES VIA A MUCUS FISTULA ● 2/2

- Pass lubricated catheter into mucus fistula up to 2 cm past end holes
- If using a Foley catheter put only 0.5 mL water into balloon
- Secure catheter to the abdomen with Duoderm®, tape and leave *in situ*
- Cover mucus fistula with paraffin gauze dressing (e.g. Jelonet)
- Collect stoma fluid from acting stoma into enteral syringe, connect to catheter via extension tube and start re-cycling using syringe pump
- Aim to infuse stoma loss over a few hours, but ≤4 hr. Discard any effluent older than 4 hr
- If stoma loss <5 mL, re-cycle by syringe as a slow bolus over a few minutes
- Re-cycling should result in bowel actions per rectum of a consistency thicker than the stoma loss
- If bowel actions per rectum are watery and/or frequent, send samples for culture and sensitivity, virology and detection of fat globules and reducing substances. Discuss with surgical team
- If baby develops signs suggestive of sepsis, stop procedure and perform septic screen as per unit policy. Discuss with surgical team

Preparation for home

- Liaise with neonatal surgical nurse
- Teach parents the procedure
- Order equipment via colorectal nurse
- Refer to colorectal nurses (bwc.colorectalnurses@nhs.net) who will arrange follow-up
- Ward will supply 14 days' equipment
- Inform surgical team before discharge

MANAGEMENT OF RELUCTANT FEEDING IN HEALTHY BABIES ≥37 WEEKS


Birth
• Dry baby/keep warm
• Initiate and maintain effective skin-to-skin contact for ≥1 hr or until after first feed
• Discuss signs of rooting/readiness to feed
• Encourage mother to feed responsively when rooting/feeding cues are shown
• First feed in skin-to-skin contact, preferably within 1 hr
• For formula-fed babies follow chart but give formula milk instead of colostrum
Fed effectively?
Yes
No
6–8 hr following birth:
• 2nd feed completed?
Fed effectively?
Yes
No
1–2 hr following birth:
• Maintain effective skin-to-skin contact
• Review in 1–2 hr
• Assess wellbeing of baby and record observations on chart
• If breastfeeding encourage mother to hand express and give colostrum to baby
Fed effectively?
Yes
No
Initiate active feeding plan† (see below)
Complete initial formal breastfeeding assessment
• Within 6 hr of birth, or once feeding initiated assess:
◦ signs of effective feeding
◦ if breastfeeding pain free for mother
◦ maternal concerns
◦ breast/nipple damage
◦ if baby showing rooting cues
• Monitor well-being*
Once baby is feeding successfully, complete breastfeeding assessments as per local guidelines
*Monitor wellbeing of baby at least 4-hrly
• Check
◦ any maternal concerns
◦ colour
◦ tone
◦ respiratory wellbeing
◦ temperature
◦ alertness/level of consciousness
◦ number and colour/consistency of wet and dirty nappies
◦ risk of and signs of sepsis
• If any signs of illness refer to neonatal team
• If any concerns about possible hypoglycaemia or ill-health, refer to relevant guideline
†Active feeding plan
Healthy term baby can be expected to feed ≥4 times in first 24 hr
• Maintain effective skin-to-skin contact
• Review baby feeding and wellbeing every 2–4 hr
• Feed when baby shows rooting cues. If cues not demonstrated offer breast 2–3 hrly
• If parent intends to breastfeed: hand express ≥8 times in 24 hr to obtain colostrum and stimulate/protect supply)
• Breast pumps can be used alongside hand expression to stimulate supply in the first few days and to collect breastmilk when milk volumes increase
• Continue to give expressed breast milk and actively support until successfully breastfeeding
• Avoid teats, dummies and nipple shields
• Support mother: listen/action any ill health concerns; teach signs of effective feeding; signpost to additional feeding support
• If any concerns, discuss with neonatal team
• Monitor wellbeing of baby at least 4-hrly*
• Continue until feeding issue resolves

DEFINITION

- Failure of the kidneys to maintain metabolic stability in relation to fluid balance, electrolyte balance and excretion of nitrogenous waste
- Serum creatinine shortly after birth is a reflection of maternal renal function

MAIN CAUSES

Prenatal injury/vascular damage

- Maternal use of:
- ACE inhibitors, angiotensin 2 receptor antagonist
- NSAID

Congenital renal disorders

- Renal agenesis
- Renal dysplasia/hypoplasia
- Polycystic kidney disease
- Congenital nephrotic syndrome (Finnish type)

Postnatal renal disease

Pre-renal

- Decreased intravascular volume/tissue perfusion
- perinatal haemorrhage
- dehydration
- hypotension
- third space losses (sepsis, NEC)
- congestive cardiac failure
- pericardial tamponade

Intrinsic renal

- Acute tubular necrosis
- Perinatal asphyxia
- Drug induced
- aminoglycosides
- amphotericin B
- IV contrast media
- NSAID
- ACE inhibitors
- Renal artery/vein thrombosis

Post-renal/obstructive

- Posterior urethral valves
- Obstruction in a single kidney
- Spinal cord pathology – neurogenic bladder
- Inappropriate ADH in ventilated babies causes transient oliguria
- will correct spontaneously as lung compliance improves

HISTORY AND EXAMINATION

- Evaluate to differentiate between pre-renal, intrinsic or post-renal problem
- Detailed clinical history
- assessment of gestational age
- antenatal ultrasound scans
- maternal medications (nephrotoxic)
- birth history
- fetal heart rate monitoring
- resuscitation
- postnatal events (e.g. hypotension, nephrotoxic medications)
- Clinical assessment for volume status
- signs of depletion/hypovolaemia

- cold peripheries
- delayed capillary refill
- tachycardic
- oliguric (<1 mL/kg/hr) or anuric
- Clinical signs of hypervolaemia/volume overload
- tachypnoeic
- oedema
- excessive weight gain
- raised blood pressure
- gallop rhythm
- hepatomegaly

INVESTIGATIONS

Blood

- FBC with red cell morphology
- Coagulation screen
- Serum U&E, calcium, phosphate, total protein, albumin, magnesium
- Blood gases
- Blood culture and CRP

Urine

- Dipstick for blood and protein
- Osmolality
- Culture and sensitivity
- Electrolytes
- Random urine protein:creatinine ratio
- Fractional excretion of sodium – (urine Na × plasma creatinine)/(urine creatinine × plasma Na) × 100
- may not be useful in preterm infants
- Renal failure index (urinary Na/urinary creatinine) × 100

Imaging

- Ultrasound scan of urinary tract
- If UAC in place, abdominal X-ray to check position of tip
- ensure tip not close to vertebra L1 (origin of renal artery)

DIAGNOSTIC INDICES

Indices	Pre-renal	Intrinsic
Urine osmolality	≥400	<400
Urine analysis	Normal	>5 RBCs
Urine sodium mmol/L	31 +/- 19	63 +/- 35
Urine protein/creatinine ratio	29 +/- 16	10 +/- 4
Fractional excretion of Na	<2.5	≥2.5
Renal failure index	<3	≥3

PREVENTION

- Ensure adequate fluid intake particularly in very preterm babies with excessive transepidermal water loss (see **Fluid balance** below)
- Extra care required when using radiant heaters in contrast to high humidification in incubator (see **Hypothermia** guideline)
- Maintain a safe blood pressure (see **Hypotension** guideline)

MONITORING

- Weigh 12-hrly
- BP 12-hrly
- Cardiac monitor to detect arrhythmias
- Strict documentation of fluid input and output
- Daily:

- cumulative fluid balance
- evaluate medications
- monitor drug levels

Urine
- Dipstick (proteinuria; sediment, e.g. blood, casts, tubular debris, indicate intrinsic problem; WBC and nitrites suggest infection)
- Microscopy and culture
- Electrolytes, urea, creatinine, osmolality

Blood
- U&E, creatinine 12-hrly (monitor Na and K on blood gas when possible)
- Blood gases, pH 4–8 hrly
- Glucose 4-hrly
- Daily:
- calcium
- phosphate
- magnesium
- albumin
- FBC

Typical biochemical changes in acute renal failure (ARF)
Increased urea, creatinine, K^+, PO_4^{3-}
Reduced Na^+, Ca^{2+}, HCO_3^- pH

- Increasing urine output generally first sign of recovery
- Monitor serum electrolyte levels during polyuric phase
- Creatinine estimation often misleading in first few days (in-utero creatinine is cleared by placenta)
- after delivery creatinine production by muscles is not stable and can be influenced heavily by muscle damage resulting from delivery/hypoxia/sepsis
- >48–72 hr, it can be used, but trend much more valuable than absolute concentration
- Urea estimation
- can be influenced by tissue breakdown (e.g. bruises/swallowed blood)
- little produced when protein intake compromised

TREAMENT

Correct underlying cause

Pre-renal failure
- Correct hypovolaemia – avoid over-hydration in established renal failure
- sodium chloride 0.9% 10–20 mL/kg IV
- if blood loss known/ suspected: give 10–20 mL/kg packed red cells
- if hypotensive in absence of fluid depletion: start inotrope infusion (see **Hypotension** guideline)
- Open duct in duct-dependent circulation in congenital heart disease (see **Cardiovascular** guidelines)
- Antibiotics for sepsis

Intrinsic renal failure
- Goal is to limit further renal damage
- Management of fluid and electrolyte imbalance and hypertension
- In majority of cases kidneys will recover in 24–48 hr

Post-renal failure
- Surgical approach to obstructive uropathy unless very poor prognosis (e.g. Potter's syndrome)
- Post-renal obstruction (e.g. posterior urethral valves) can be temporarily relieved by indwelling catheter until definitive surgical treatment considered

Supportive
- If possible, stop all nephrotoxic drugs (e.g. aminoglycosides, vancomycin, furosemide), or monitor levels if need to continue
- Assess fluid status regularly

Fluid balance
- If baby hypovolaemic/hypotensive it is important to correct this before instituting fluid restriction (see above)
- If signs of fluid overload consider trial of furosemide
- Restrict fluid intake to minimal maintenance fluids
- Calculate maintenance fluid:
- maintenance fluid = insensible losses + urine output + GIT losses
- insensible losses (if nursed in incubator):
  - <1000 g: 60−80 mL/kg/day
  - 1000−1500 g: 40−60 mL/kg/day
  - >1500 g: 20 mL/kg/day
  - for babies in well-humidified incubator or receiving humidified respiratory support, use lower figure
- Replace maintenance fluid as glucose 10–20% (electrolyte-free)
- If electrolyte losses ongoing (e.g. diarrhoea, fistula), electrolytes required
- Weigh twice daily
- change in body weight best guide to change in hydration
- stable weight indicates over-hydration and need to reduce fluid intake further
- aim to achieve 1% loss of body weight daily

Hyperkalaemia
- See **Hyperkalaemia** guideline

Acidosis
- Monitor pH 4–8 hrly
- If metabolic acidosis present with pH <7.2 or HCO_3 <12 mmol/L, give sodium bicarbonate
- Monitor ionised calcium levels to prevent seizures/tetany

Hyponatraemia
- Low sodium more likely to indicate fluid overload than deficit in body sodium
- Unless evidence of dehydration, treatment should be fluid restriction with maintenance sodium intake of 2–3 mmol/kg/day
- If severe (Na <120 mmol/L) and associated with neurological symptoms, e.g. seizures, can use hypertonic saline (sodium chloride 3%) 4 mL/kg over a minimum of 15 min: check serum sodium immediately after completion of infusion
- If baby still fitting, dose can be repeated **after** assessing serum sodium concentration
- Amount of Na required = (desired Na – actual Na) × 0.6 × weight
- sodium chloride 3% contains 0.5 mmol/mL of sodium
- Correct serum Na concentration cautiously (maximum daily correction 8–10 mmol/L) to avoid development of neurological sequelae
- During recovery phase, babies rarely become polyuric, when sodium chloride 0.45% is typically required, although this will depend on measurement of urinary sodium concentration

Calcium and phosphate imbalances
- Hyperphosphataemia and hypocalcaemia are known complications in neonates
- Correct symptomatic hypocalcaemia using calcium gluconate 10% 0.5–1 mL/kg IV over 5 min under ECG monitoring
- Correct hyperphosphataemia by restricting phosphate in PN or milk formulas

Nutrition
- Attention to nutrition is essential to prevent excessive tissue breakdown
- If baby tolerating oral feeds: give EBM or renal formula to give low renal solute load and low phosphate
- If oral feeds **not** tolerated: parenteral nutrition 50 kcal/kg/day and protein 1–2 mg/kg/day

Dialysis
- Hardly ever used in neonates due to technical difficulty and poor prognosis
- Only applicable to term babies with treatable renal problem
- Indications:
- severe metabolic acidosis

- persistent metabolic abnormalities e.g. hyperkalaemia
- intractable fluid overload
- Discuss with paediatric nephrology team

CONCLUSION

- Outcome dependent on cause and extent of renal damage
- Vast majority of cases of renal failure will recover if the underlying cause is addressed and supportive management provided to maintain fluid and electrolyte balance until recovery takes place, normally over 24–48 hr
- If there is no improvement, discuss with paediatric nephrologist

- Check equipment daily, and before resuscitation
- Follow Resuscitation Council UK Guidelines https://www.resus.org.uk/library/2021-resuscitation-guidelines/newborn-resuscitation-and-support-transition-infants-birth
- Ensure delivery room is warm (23–25°C), windows closed and fans switched off
- Delivery room should be >25°C for babies ≤28 weeks gestation

CORD CLAMPING

- Uncompromised term and preterm babies: delay cord clamping (DCC) for ≥1 min from complete delivery of baby℅
- Stripping (milking) of the cord can be performed in babies ≥28 weeks' gestation if DCC not feasible
- If immediate resuscitation required, clamp cord as soon as possible

DRY AND COVER

- ≥32 weeks' gestation: dry baby, **remove wet towels** and cover baby with **warm, dry towels**
- <32 weeks' gestation: do not dry body but place baby in plastic bag/sterile suit (Neohelp™ bag) feet first, and tuck in sides at the neck to fully enclose baby's torso. Dry head only and put on hat
- Aim to maintain body temperature 36.5–37.5°C (unless decision taken to start therapeutic hypothermia)
- Preterm ≤32 weeks' gestation may require additional interventions to maintain target temperature:
  - warmed humidified respiratory gases
  - thermal mattress alone
  - increased room temperature (to 25°C) plus plastic wrapping of head and body, plus thermal mattress

ASSESS

- Assess **colour, tone, breathing and heart rate**

If baby very floppy and heart rate slow, assist breathing immediately

- Reassess heart rate, breathing and chest movement every 30 sec throughout resuscitation process
- If help required, request **immediately**

CHECK AIRWAY

For baby to breathe effectively, airway must be open

- To open airway, place baby supine with head in **'neutral position'** with neck neither flexed nor extended
- If very floppy, give chin support or jaw thrust while maintaining the neutral position

IMMEDIATE TREATMENT

Airway

- Keep head in neutral position
- Use T-piece and soft round face mask, extending from nasal bridge to chin
- Give 5 inflation breaths, sustaining inflation pressure (**Table 1**) for 2–3 sec for each breath
- Give peak end expiratory pressure (PEEP) of 5 cm H_2O
- Inflation breaths:
  - term: start in air
  - preterm
    - ≥32 weeks: start in air
    - 28–31 weeks: use low oxygen concentration (21–30%)
    - preterm <28 weeks; use 30%
- Look for chest movement

Table 1: Inflation pressure (avoid using pressure higher than recommended)

Term baby	30 cm H_2O
Preterm baby	25 cm H_2O

No chest movement

Ask yourself:

- Is head in neutral position?
- Is a jaw thrust required?
- Do you need a second person to help with airway to perform 2-handed jaw thrust?
- Is there an obstruction? Do you need to look with a laryngoscope and undertake suction with a large-bore device?
- Consider intubation to secure airway if skilled, or placing a laryngeal mask airway (LMA) or i-gel under direct vision using laryngoscope in babies ≥34 weeks/>2 kg
- i-gels have been used in babies down to 1.5 kg
- Insertion of oropharyngeal airway or naso-pharyngeal airway if unable to secure airway by other means
- Is inflation time long enough?
- if no chest movement occurs after alternative airway procedures above have been tried (volume given is a function of time and pressure), a larger volume can be delivered if necessary by inflating for a longer time (3–4 sec) or gradually by increasing the peak inspiratory pressure (PIP)
- Attach saturation monitor to right hand – see **Saturation monitoring** for guidance on SpO_2 targets

Endotracheal intubation

- Nasal continuous positive airway pressure (CPAP) rather than routine intubation may be used to provide initial respiratory support of all spontaneously breathing preterm babies with respiratory distress

Indications

- Severe hypoxia (e.g. terminal apnoea or fresh stillbirth)
- Stabilisation of airway
- Congenital diaphragmatic hernia [see **Congenital diaphragmatic hernia (CDH)** guideline]
- to be electively intubated by most experienced person present
- **NEVER** give mask ventilation

Safe insertion of endotracheal tube (ETT) requires skill and experience
If you cannot insert an ETT within 30 sec, revert to mask ventilation
Capnography can help to assess ETT placement (see* Intubation *guideline)

Breathing

- Most babies have a good heart rate after birth and establish breathing by 90 sec
- if not breathing adequately give **5 inflation breaths**, preferably using air at pressures in **Table 1**
- Heart rate should rapidly increase as oxygenated blood reaches heart

Do not move on to ventilation breaths unless you have a heart rate response OR you have seen chest movement

Review assessment after inflation breaths

- Is there a rise in heart rate?
- Is there chest movement with the breaths you are giving?
- If no spontaneous breathing, provided the heart rate has increased and chest movement has been obtained, perform 30 sec of **ventilation breaths**, given at a rate of 30 breaths/min (1 sec inspiration)

Table 2: Outcome after 30 sec of ventilation breaths

Heart rate	Breathing	Action
Increases	Not started breathing	• Provide 30 breaths/min • Where available, use PEEP at 5 cm H_2O with T-piece system
<60 bpm	Obvious chest movement	• Start chest compressions (see **Chest compression**) • Increase inspired oxygen concentration to 100%

Chest compression

- Use if heart rate approximately <60 bpm (do not try to count heart rate accurately as this will waste time)

Start chest compression only after successful inflation of lungs

Figure 1

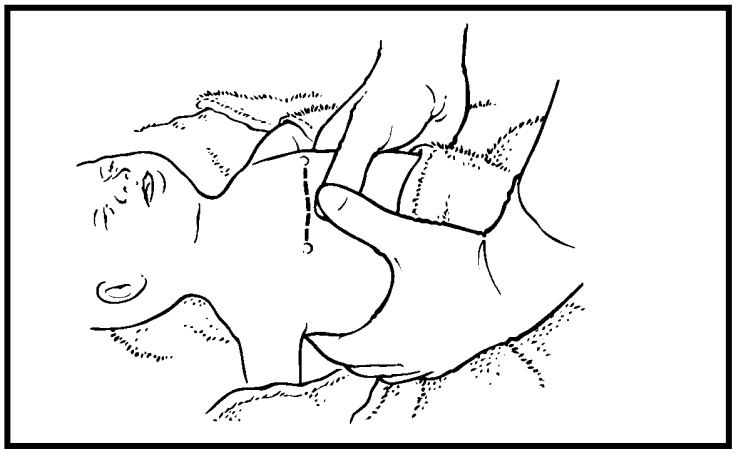
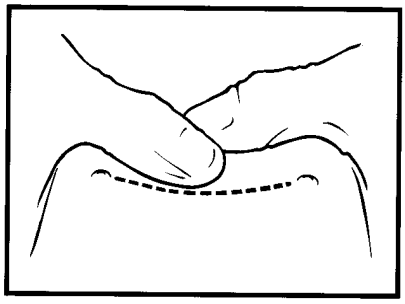
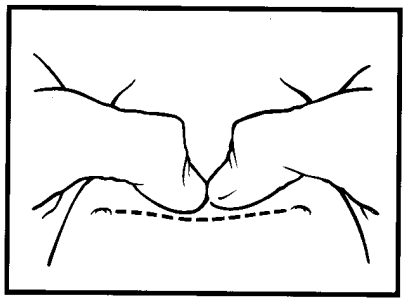


Figure 2





Pictures taken from NLS manual and Resuscitation Council (UK) and reproduced with their permission

Ideal hold (Figure 1/Figure 2)

- Circle chest with both hands so that thumbs can press on the sternum just below an imaginary line joining the nipples with fingers over baby's spine

Alternative hold (less effective)

- Compress lower sternum with fingers while supporting baby's back. The alternative hand position for cardiac compressions can be used when access to the umbilicus for umbilicus venous catheterisation is required, as hands around the chest may be awkward

Action

- Compress chest quickly and firmly to reduce the antero-posterior diameter of the chest by about one-third, followed by full re-expansion to allow ventricles to refill
- remember to relax grip on the chest during IPPV, and feel for chest movement during ventilation breaths, as it is easy to lose neutral position when cardiac compressions are started

Co-ordinate compression and ventilation to avoid competition.
Aim for 3:1 ratio of compressions to ventilations
and 90 compressions and 30 breaths (120 'events') per min

Resuscitation drugs
- Always ask about drugs taken recently by, or given to mother
- Give drugs only if there is an undetectable or slow heartbeat despite effective lung inflation and effective chest compression
- Umbilical venous catheter (UVC) is the preferred route for urgent venous access
- Intraosseous (IO) access can be an alternative method of emergency access for drugs/fluids
- Recommence cardiac compressions and ventilation breaths ratio 3:1 after each drug administration and re-assess after 30 sec
- If no heart rate increase, progress onto next drug

Adrenaline 1:10,000
- 0.2 mL/kg 1:10,000 (20 microgram/kg) IV, repeated every 3–5 min
- Administration via ETT, use only when IV access not available; dose is 1 mL/kg (100 microgram/kg) 1:10,000

Sodium bicarbonate 4.2%
- 1–2 mmol/kg (2–4 mL/kg) IV (never give via ETT)

Glucose 10%
- 2.5 mL/kg IV slowly over 5 min

Sodium chloride 0.9%
- 10 mL/kg IV

Blood
- If there is evidence of fetal haemorrhage and hypovolaemia, consider giving O negative emergency blood

Naloxone
- Give only after ventilation by mask or ETT has been established with chest movement seen and heart beat >100 bpm
- If mother has been given pethidine within 2–4 hr of delivery, give naloxone IM:
  - 100 microgram (0.25 mL) for small preterm babies
  - 200 microgram (0.5 mL) for all other babies

WHEN TO STOP
- If no sign of life after 20 min, outlook is poor with few survivors; majority will have cerebral palsy and learning difficulties

Continue resuscitation until a senior member of staff advises stopping

ONGOING MANAGEMENT
Saturation monitoring
- Oxygen monitoring is activated when paediatrician/2nd pair of hands arrives. In the meantime, the person initiating resuscitation carries out all the usual steps in resuscitation
- Do not stop resuscitation for a saturation probe to be attached
- Attach saturation probe to the right hand and connect to the monitor once 5 inflation breaths have been given
- SpO_2 should spontaneously improve as **Table 3**

Table 3

Time (min)	Acceptable preductal SpO_2 (%)
2	65
5	85
10	90

Heart rate monitoring
- Best by listening with stethoscope

- Pulse oximetry
- ECG monitoring, if available, can give rapid accurate and continuous heart rate reading. However it does not indicate the presence of a cardiac output and should not be the sole means of monitoring

Air to oxygen

- Titrate the oxygen to saturation levels once SpO_2 trace has been obtained
- If chest compressions required following chest movement with inflation breaths, increase oxygen to 100%
- If SpO_2 above levels in **Table 3** or >95% at 10 min of life, reduce oxygen

Meconium deliveries

- Do not attempt to suction nose and mouth whilst head is on perineum
- In non-vigorous babies born through meconium, immediate laryngoscopy with/without suction after delivery not recommended
- Only intubate if suspected tracheal obstruction, routine intubation is not necessary

Preterm deliveries

- Nasal CPAP rather than routine intubation may be used to provide initial respiratory support of all spontaneously breathing preterm babies with respiratory distress. Give PEEP at 5 cm H_2O via mask ventilation with oxygen supplementation as appropriate on the resuscitaire and continue PEEP support during transfer to NNU
- If respiratory effort is poor at any point, or baby's condition deteriorates, intubate and ventilate

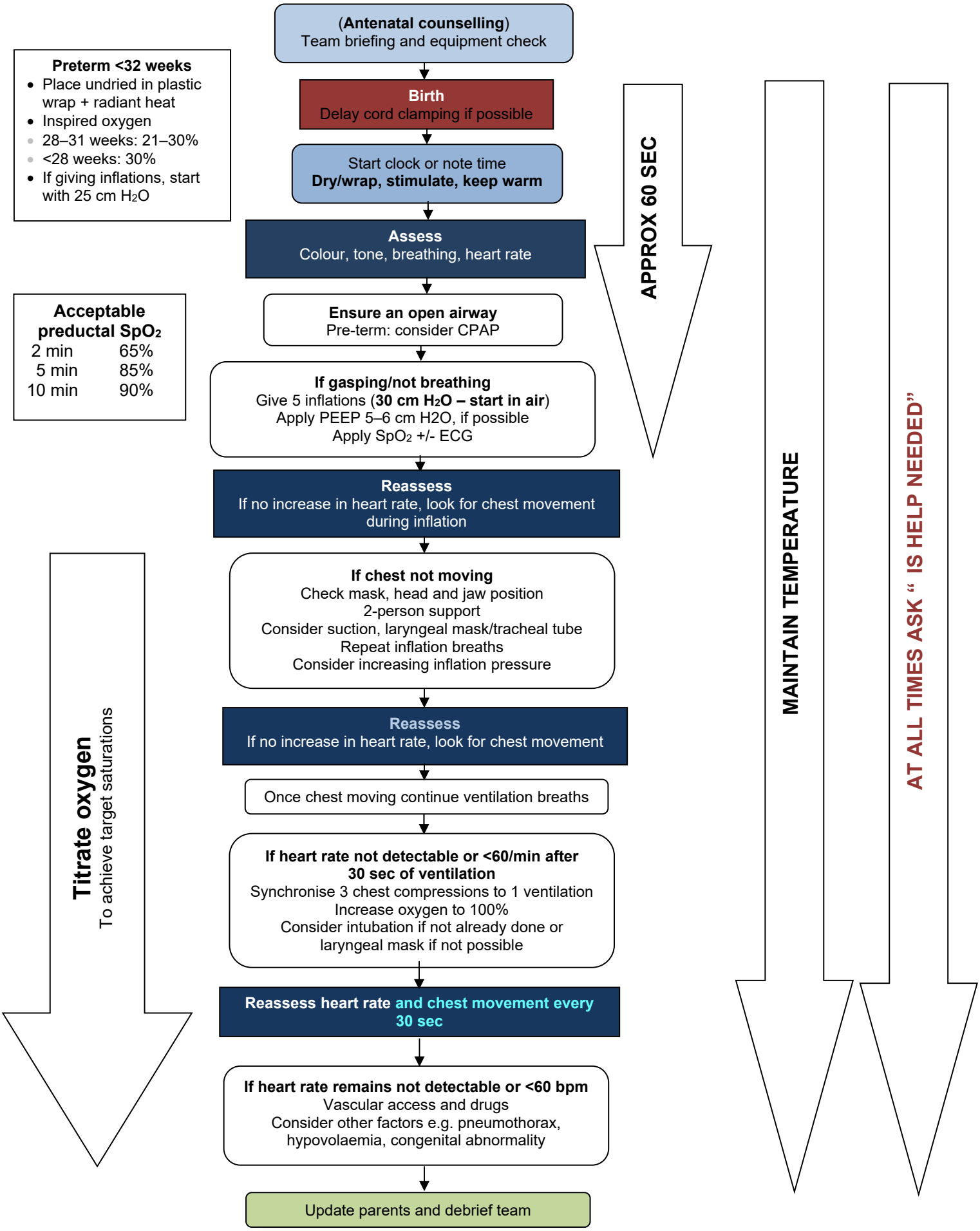
DOCUMENTATION

- Make accurate written record of facts (not opinions) as soon as possible after the event
- This should be recorded on the **BadgerNet** system. In babies where resuscitation has been unsuccessful, a new baby episode of 'labour ward death' should be created and resuscitation documentation completed
- **Record:**
- when you were called, by whom and why
- condition of baby on arrival
- what you did and when you did it
- timing and detail of any response by baby – time of first heart rate, first heart rate >100 bpm, first gasp if any, and when spontaneous breathing resumed
- date and time of writing your entry

COMMUNICATION

- Inform parents what has happened (the facts)

Newborn life support algorithm


(Antenatal counselling)
Team briefing and equipment check
Birth
Delay cord clamping if possible
Start clock or note time
Dry/wrap, stimulate, keep warm
Assess
Colour, tone, breathing, heart rate
Ensure an open airway
Pre-term: consider CPAP
If gasping/not breathing
Give 5 inflations (30 cm H2O – start in air)
Apply PEEP 5–6 cm H2O, if possible
Apply SpO2 +/- ECG
Reassess
If no increase in heart rate, look for chest movement during inflation
If chest not moving
Check mask, head and jaw position
2-person support
Consider suction, laryngeal mask/tracheal tube
Repeat inflation breaths
Consider increasing inflation pressure
Reassess
If no increase in heart rate, look for chest movement
Once chest moving continue ventilation breaths
If heart rate not detectable or <60/min after 30 sec of ventilation
Synchronise 3 chest compressions to 1 ventilation
Increase oxygen to 100%
Consider intubation if not already done or laryngeal mask if not possible
Reassess heart rate and chest movement every 30 sec
If heart rate remains not detectable or <60 bpm
Vascular access and drugs
Consider other factors e.g. pneumothorax, hypovolaemia, congenital abnormality
Update parents and debrief team
Preterm <32 weeks
• Place undried in plastic wrap + radiant heat
• Inspired oxygen
• 28–31 weeks: 21–30%
• <28 weeks: 30%
• If giving inflations, start with 25 cm H2O
Acceptable preductal SpO2
2 min 65%
5 min 85%
10 min 90%
APPROX 60 SEC
MAINTAIN TEMPERATURE
AT ALL TIMES ASK " IS HELP NEEDED"
Titrate oxygen
To achieve target saturations

RETINOPATHY OF PREMATURITY (ROP)

INDICATIONS FOR SCREENING

- All babies either <1501 g birth weight or ≤31^{+6} weeks' gestation

PROCEDURE

When to screen

Table 1

Indication	When to start screen
Born <31^{+0} weeks' gestation	31^{+0}–31^{+6} weeks' postmenstrual age **OR** at 4 completed weeks postnatal age (28−34 days), whichever is later
Born 31^{+0}–31^{+6} weeks' gestation irrespective of birth weight, or ≥32^{+0} weeks' gestation but weight <1501 g	36 weeks' postmenstrual age **OR** at 4 completed weeks postnatal age (28−34 days) whichever is sooner

- If baby to be discharged before first screening due, bring eye examination forward to be seen before discharge

Table 2: Timing of first screening according to gestational age

	Age at first screen (weeks*)	
Gestational age	Postmenstrual age	Postnatal age
22	31	9
23	31	8
24	31	7
25	31	6
26	31	5
27	31	4
28	32	4
29	33	4
30	34	4
31	35	4
32 (<1501 g)	36	4
33 (<1501 g)	36	3
34 (<1501 g)	36	2
35 (<1501 g)	36	1

*completed weeks (i.e. 22 = 22^{+0}–22^{+6})

How to screen

- Arrange screening with ophthalmologist as per local agreement

Preparation for screening

- Prescribe eye drops night before screening on drug chart
- Phenylephrine 2.5% and cyclopentolate 0.5%
- instil 1 drop of each drug. Give 2 doses, 5 min apart, 1 hr before examination. Timings may vary according to Trust practice – check local guidance
- if in any doubt whether drop has gone into eye, give another drop immediately (pupil must be fully dilated)
- close eyelids after instillation of eye drops, wipe off any excess

Care during procedure

- A competent doctor/ANNP available during eye examinations
- Use comfort care techniques (nesting, swaddling +/- dummy). Parents to be offered opportunity to provide this

- Consider giving oral expressed breast milk or oral sucrose 0.1–0.5 mL just before examination (maximum 3 doses)
- Proxymetacaine 0.5% or oxybuprocaine 0.4% as topical anaesthesia just before examination when an eyelid speculum is to be used
- Avoid bright light and cover incubator/cot for 4–6 hr after examination

How often to screen

- If treatment not required after first ROP screen, screen **weekly** if any of the following are present:
  - vessels ending in zone I or posterior zone II with or without any stage of ROP
  - any plus or pre-plus disease
  - any stage 3 ROP in zone II or III
- Continue with weekly screening until criteria for 2-weekly screening or discontinuing screening are met

2-weekly screening criteria

- Vessels end in mid or anterior zone II or in zone III; **AND**
- No plus or pre-plus disease; **AND**
- No ROP, or stage 1 or 2 ROP
- Continue 2-weekly screening until criteria for treatment, weekly screening or stopping screening are met

When to stop screening

- If no ROP, continue until vascularisation has extended into zone III
  - if uncertainty about the zone, consider a further confirmatory examination 2 weeks later
- If any stage of ROP, continue until any characteristics of regression seen on ≥2 consecutive examinations:
  - partial resolution progressing towards complete resolution
  - change in colour of the ridge from salmon pink to white
  - growth of vessels through the demarcation line

TREATMENT CRITERIA

- Zone I with plus disease and with any stage of ROP
- Zone I without plus disease but with stage 3 ROP
- Zone II with plus disease and with stage 3 ROP
  - zone II stage 2 with plus disease is borderline for treatment and may be treated or re-examined in 1 week or sooner
- Plus disease should be present in ≥2 quadrants
- Aggressive ROP (A-ROP)

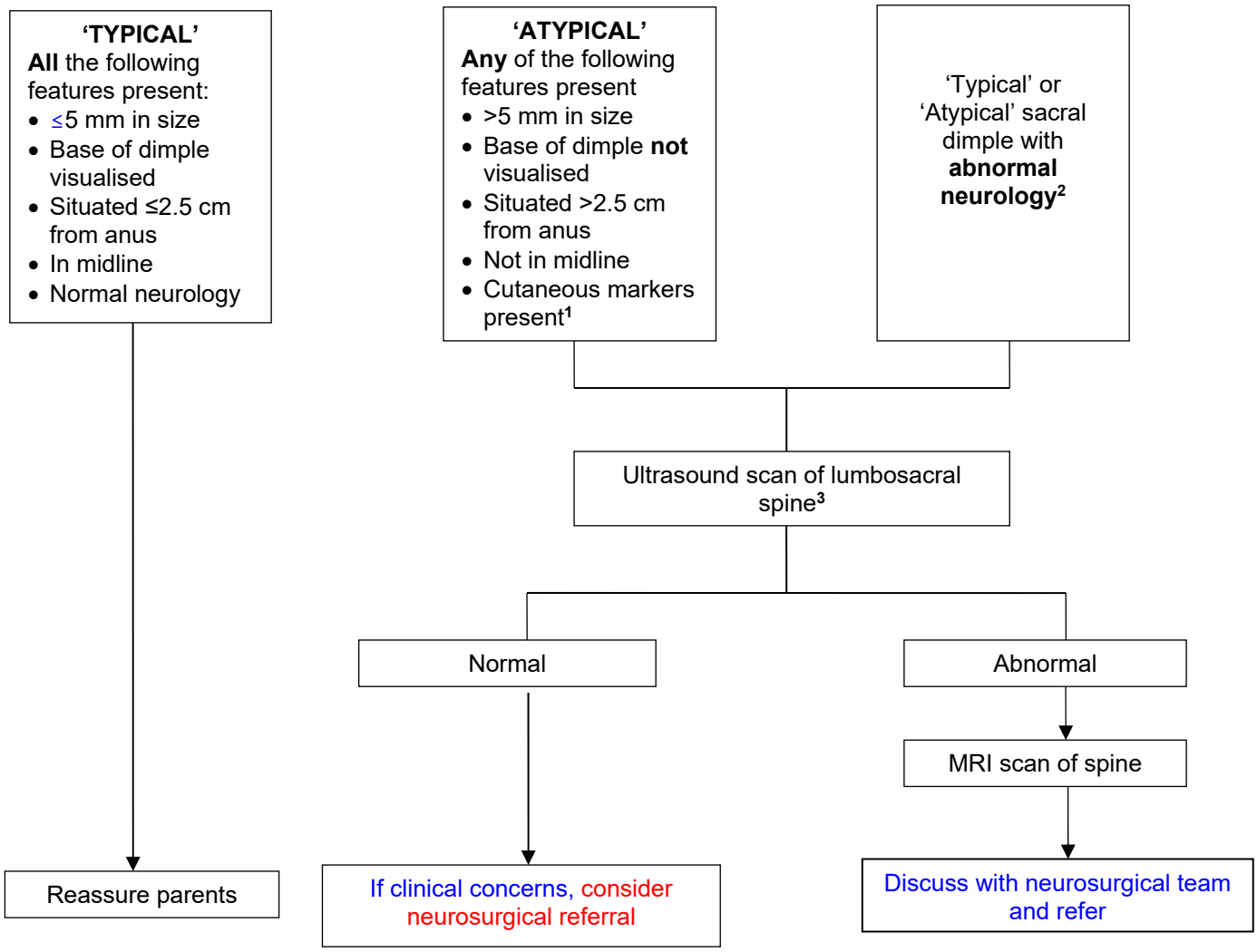
Discuss with treating ophthalmologist when referral warranted ROP is present (see https://www.rcpch.ac.uk/sites/default/files/2024-10/rop-screening-guideline-full-2022_updated-2024.pdf 'Appendix E: Algorithm for Ophthalmic Observations')

- Any pre-plus or plus disease in ≥2 quadrants in any zone
- Any zone I or posterior zone II disease
- Any stage 3 disease in any zone

AFTERCARE

- Complete ad hoc ROP form in **BadgerNet** documentation
- Eye examination results and recommendations for further screening must be included in transfer letter, together with ophthalmological status, future recommendations for screening intervals and outpatient follow-up arrangements
- Subsequent examinations must be documented by ophthalmologist in baby's medical notes

SACRAL DIMPLE● 1/1


'TYPICAL'
All the following features present:
• ≤5 mm in size
• Base of dimple visualised
• Situated ≤2.5 cm from anus
• In midline
• Normal neurology
'ATYPICAL'
Any of the following features present
• >5 mm in size
• Base of dimple **not** visualised
• Situated >2.5 cm from anus
• Not in midline
• Cutaneous markers present[1]
'Typical' or 'Atypical' sacral dimple with **abnormal neurology**[2]
Ultrasound scan of lumbosacral spine[3]
Normal
Abnormal
MRI scan of spine
Reassure parents
If clinical concerns, consider neurosurgical referral
Discuss with neurosurgical team and refer

Notes

1. **Cutaneous markers of occult spinal dysraphism** e.g. dermal sinus, pigmentation and hairy patch, abnormal skin texture, lipoma, cyst, skin tag, haemangioma and swelling, asymmetric gluteal crease (deviated or duplicated gluteal cleft); cutaneous markers can be seen in isolation or any combination
2. Check for neurological signs in lower limbs – leg movements, tone, deep tendon reflexes, presence of patulous anus etc.
3. Babies with abnormal neurology may need discussion with neurosurgery team and inpatient investigations. For other cases, evidence in literature suggests delaying ultrasound scan of lumbosacral spine beyond 30 days, but within 3 months for accurate evaluation.

SEIZURES ● 1/5

Neonatal seizures are a manifestation of neurological dysfunction. Seizures occur in 1–3% of term newborn babies and in a greater proportion of preterm babies. They can be subtle, clonic, myoclonic or tonic

RECOGNITION AND ASSESSMENT

Physical signs

In addition to obvious convulsive movements, look for:

- Eyes: staring, blinking, horizontal deviation
- Oral: mouthing, chewing, sucking, tongue thrusting, lip smacking
- Limbs: boxing, cycling, pedalling
- Autonomic: apnoea, tachycardia, unstable blood pressure
- Focal (1 extremity) or multifocal (several body parts)
- Perform a detailed physical examination and neurological assessment

Differential diagnosis

- Jitteriness: tremulous, jerky, stimulus-provoked and ceasing with passive flexion
- Benign sleep myoclonus: focal or generalised, myoclonic limb jerks that do not involve face, occurring when baby is going to or waking up from sleep; EEG normal; resolves by aged 4–6 months
- Differentiation between jitteriness and seizures:

Table 1

Sign	Jitteriness	Seizure
Stimulus provoked	Yes	No
Predominant movement	Rapid, oscillatory, tremor	Clonic, tonic
Movements cease when limb is held	Yes	No
Conscious state	Awake or asleep	Altered
Eye deviation	No	Yes

Investigations

First line

- Blood glucose
- Serum electrolytes including calcium, magnesium
- FBC and coagulation (if stroke suspected, thrombophilia screen)
- Blood gases
- Blood culture
- CRP
- LFT
- Serum ammonia, amino acids
- Urine toxicology, amino acids, organic acids
- Lumbar puncture – CSF microscopy and culture (bacterial and viral PCR for herpes simplex including enterovirus)
- discuss CSF sample for further metabolic testing [e.g. glycine, lactate etc. (as guided by metabolic testing)] with consultant
- Cranial ultrasound scan (to exclude intracranial haemorrhage)
- EEG (to identify electrographic seizures and to monitor response to therapy). Consider cerebral function monitor (CFM–aEEG)

Second line

- Congenital infection screen (TORCH screen)
- MRI scan
- Screen for maternal substance abuse
- Serum acylcarnitine, biotinidase, VLCFA, uric acid, sulphocysteine, total and free homocysteine
- Trial of pyridoxine treatment, preferably during EEG monitoring, may be diagnostic as well as therapeutic
- If further advice required, contact metabolic team

TREATMENT

- Ensure ABC
- Treat underlying cause (hypoglycaemia, electrolyte abnormalities, infection)

- hypoglycaemia: give glucose 10% 2.5–5 mL/kg IV bolus, followed by maintenance infusion. Wherever possible, obtain 'hypoglycaemia screen' (see **Hypoglycaemia** guideline) before administration of glucose bolus
- hypocalcaemia (total Ca <1.7 mmol/L or ionised Ca <0.64 mmol/L): give calcium gluconate 10% 0.5 mL/kg IV over 5–10 min with ECG monitoring (risk of tissue damage if extravasation) (see **Hypocalcaemia** guideline)
- hypomagnesaemia (<1 mmol/L): give magnesium sulphate 100 mg/kg IV or deep IM (also use for refractory hypocalcaemic seizure)
- Pyridoxine (50–100 mg IV) can be given to babies unresponsive to conventional anticonvulsants or seek neurologist opinion

Initiation of anticonvulsants (for immediate management follow flowchart)

- Start anticonvulsant drugs when:
- prolonged: >2–3 min
- frequent: >2–3/hr
- associated with cardiorespiratory compromise (frequent apnoeas and bradycardia requiring intervention)

Administration

- IV to achieve rapid onset of action and predictable blood levels
- To maximum dosage before introducing a second drug
- If no IV access and glucose and electrolyte abnormalities excluded, consideration can be given to buccal/intranasal midazolam

Maintenance and duration of treatment

- Keep duration of treatment as short as possible. This will depend on diagnosis and likelihood of recurrence
- May not require maintenance therapy after loading dose
- If maintenance therapy is required:
- monitor serum levels
- develop emergency seizure management plan, including, if required, a plan for buccal/intranasal midazolam

Stopping treatment

- Consider when:
- seizures have ceased and neurological examination is normal or
- abnormal neurological examination with normal EEG

Anticonvulsant drug therapy schedule
(also see **Flowchart: Immediate management** below)

Drug	Loading dose	Maintenance dose
Phenobarbital	• 20 mg/kg IV – administer over 20 min • Optional additional doses of 10 mg/kg each until seizures cease or total dose of 40 mg/kg given	• 2.5–5 mg/kg IV or oral once daily beginning 12–24 hr after loading dose
Phenytoin	• 20 mg/kg IV – maximum infusion rate of 1 mg/kg/min • Monitor cardiac rate and rhythm and blood pressure for hypotension	• 2.5–5 mg/kg IV or oral 12-hrly • Measure trough levels 48 hr after IV loading dose
Midazolam (if no response to above drugs)	• Give 200 microgram/kg IV over 5 min followed by continuous infusion 60–300 microgram/kg/hr if required • Reconstitution and dilution: dilute 15 mg/kg of midazolam up to a total of 50 mL with sodium chloride 0.9%, glucose 5% or glucose 10% 0.1 mL/hr = 30 microgram/kg/hr • may cause significant respiratory depression and hypotension if injected rapidly, or used in conjunction with narcotics • If no IV access, glucose and electrolyte abnormalities excluded, give 300 microgram/kg intranasal/buccal. (**Note:** can be repeated once; wait 10 min before repeating. Ensure cardiorespiratory status stable)	
Clonazepam (if midazolam not available)	• 100 microgram/kg IV over 2 min • repeat dose after 24 hr if necessary • concurrent treatment with phenytoin reduces the half-life of clonazepam	
Lidocaine (if above medications ineffective)	• 2 mg/kg IV over 10 min, then commence infusion • 6 mg/kg/hr for 6 hr, **then** • 4 mg/kg/hr for 12 hr, **then** • 2 mg/kg/hr for 12 hr	Exercise caution with phenytoin as concurrent IV infusion of both these drugs has a cardiac depressant action (refer to **Neonatal Formulary** for doses in preterm babies)
Levetiracetam (if not responding in any order)	• Loading dose: • 20 mg/kg IV infusion over 15 min • can be repeated if seizures persist (maximum 40 mg/kg)	• 10–15 mg/kg 12-hrly IV/oral **[Note:** ½ maintenance dose in babies with severe renal impairment (creatinine >150 micromol/L)]

- **Refer to unit physiotherapist/occupational therapist (where available)**

DISCHARGE AND FOLLOW-UP

Discharge

- Ensure parent(s) are provided with appropriate discharge documentation
- seizure emergency management plan
- copy of discharge summary, including: types of seizures, medications/anticonvulsants administered

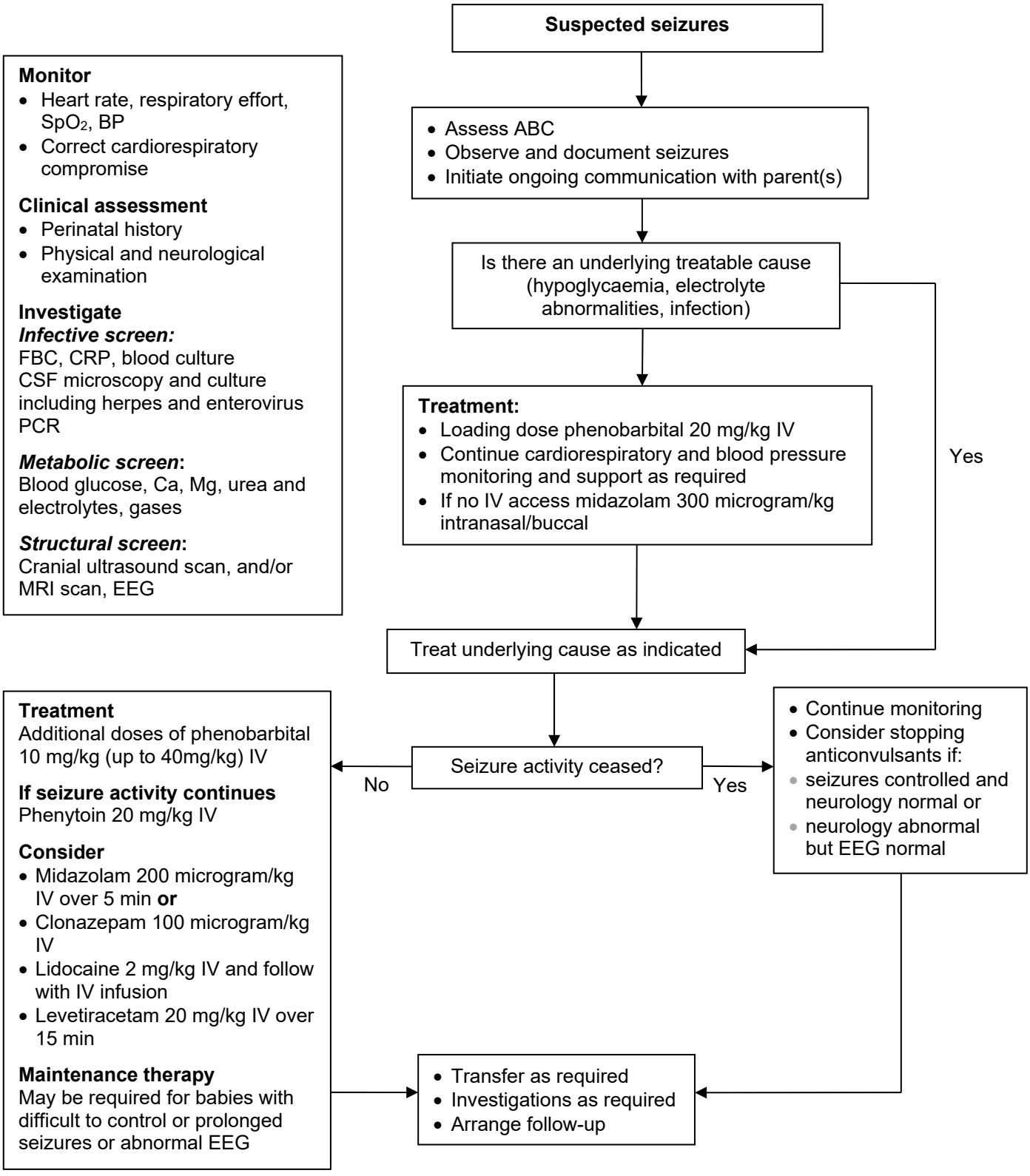
Follow-up

- Follow-up will depend on cause of seizures and response to treatment
- Consider: specialist follow-up for babies discharged on anticonvulsant drugs

- Refer to community allied health professionals on discharge as appropriate

Further information for parents
www.**bcmj**.org/**sites/default/files/HN_Seizures-newborns**.pdf

Flowchart: Immediate management


Suspected seizures
• Assess ABC
• Observe and document seizures
• Initiate ongoing communication with parent(s)
Is there an underlying treatable cause (hypoglycaemia, electrolyte abnormalities, infection)
Yes
Treatment:
• Loading dose phenobarbital 20 mg/kg IV
• Continue cardiorespiratory and blood pressure monitoring and support as required
• If no IV access midazolam 300 microgram/kg intranasal/buccal
Treat underlying cause as indicated
Seizure activity ceased?
No
Yes
• Continue monitoring
• Consider stopping anticonvulsants if:
• seizures controlled and neurology normal or
• neurology abnormal but EEG normal
• Transfer as required
• Investigations as required
• Arrange follow-up
Monitor
• Heart rate, respiratory effort, SpO2, BP
• Correct cardiorespiratory compromise
Clinical assessment
• Perinatal history
• Physical and neurological examination
Investigate
Infective screen:
FBC, CRP, blood culture
CSF microscopy and culture including herpes and enterovirus PCR
Metabolic screen:
Blood glucose, Ca, Mg, urea and electrolytes, gases
Structural screen:
Cranial ultrasound scan, and/or MRI scan, EEG
Treatment
Additional doses of phenobarbital 10 mg/kg (up to 40mg/kg) IV
If seizure activity continues
Phenytoin 20 mg/kg IV
Consider
• Midazolam 200 microgram/kg IV over 5 min or
• Clonazepam 100 microgram/kg IV
• Lidocaine 2 mg/kg IV and follow with IV infusion
• Levetiracetam 20 mg/kg IV over 15 min
Maintenance therapy
May be required for babies with difficult to control or prolonged seizures or abnormal EEG

SKIN BIOPSY FOR INBORN ERRORS OF METABOLISM ● 1/2

INDICATIONS

- Diagnosis of inherited metabolic disorders
- Wherever possible, discuss biopsy and arrangements with Department of Newborn Screening and Biochemical Genetics, Birmingham Children's Hospital 0121 333 9942
  - this should include discussion about which specimen bottles and transport medium to use
  - confirm instructions for storage and transport with your local laboratory

Skin biopsy is often collected for histological analysis. Contact your local histopathology department for advice on sample handling

EQUIPMENT

- Forceps: fine dissecting forceps
- Cotton wool balls and gallipots
- Dressing towel
- Plastic apron
- Size 15 scalpel blade and no. 3 handle
- 25 G needle (orange top)
- 23 G needle (blue top)
- 21 G needle (green top) for drawing up lidocaine
- 2 mL syringe
- Cleaning solution as per unit policy
- Lidocaine 1%
- Bottles of culture medium
- Sterile gloves
- Steri-Strip™
- Dressings:
  - 1 small transparent dressing (e.g. Tegaderm™/Opsite)
  - gauze swabs
  - elasticated cotton or other bandage

SAMPLE REQUIREMENTS

- ≥1 mm × 1 mm of skin (ideally 2 mm × 2 mm) from preferred site (e.g. inner side of forearm or posterior aspect just above elbow)
  - choose site carefully as even a small scar on coloured skin will be very obvious
  - if post-mortem, take skin from over scapula as this leaves less obvious damage (see **Post-mortem specimens**)

PROCEDURE

Consent

- Inform parents of reason for biopsy, explain procedure and risks including:
  - healing and scarring
  - possibility of contamination
  - poor growth
- Obtain and record written consent (see below for post-mortem sampling)

Technique

Maintain strict asepsis using 'non-touch' technique

- Wash hands and put on apron and sterile gloves
- Cleanse site
  - ensure cleaning fluid does not pool beneath baby
- Sedation if appropriate
- Inject lidocaine 1%, a little intradermally and remainder subcutaneously to anaesthetise an area 1.5 × 1 cm. Maximum dose 0.3 mL of 1% solution/kg
-
- Wait 5 min to ensure site anaesthetised
- Cleanse again, wipe off and dry using sterile cotton wool or gauze swabs

SKIN BIOPSY FOR INBORN ERRORS OF METABOLISM ● 2/2

Method A

- Using fine forceps, grip a fold of skin between blades so that a length of skin 3 mm × 2 mm protrudes
- slice off in 1 stroke by running scalpel blade along upper edge of forceps blades
- if skin too thick or oedematous to grip, proceed to **Method B**

Method B

- Pierce skin with 23 or 21 G needle and lift to produce 'tenting'
- cut off tip of tent to produce a round 'O' shaped piece of skin approximately 2 mm
- Place into culture medium bottle immediately (lid of bottle removed by assistant for shortest possible time)
- Complete request form with:
- clinical details
- date and time of sampling

Dressing wound

- Although it may bleed freely, wound is usually partial thickness and should not require stitching
- apply pressure to stanch bleeding
- apply Steri-Strip™ and sterile dressing, bandage if necessary
- Remove bandage after a few hours, but leave dressing for several days
- Reassure parents that scar, when visible, will be seen as a fine line

Transport

- Once sample taken, send to inherited metabolic diseases laboratory as soon as possible
- if unable to arrange transport immediately, store sample at +4°C for maximum of 12 hr before despatch, **do not freeze sample**

POST-MORTEM SPECIMENS

- In accordance with Human Tissue Act, post-mortem samples must be taken only on licensed premises (or satellites thereof). Check with your pathology laboratory manager

Specimens taken after death present a high risk of infection and possible failure of culture. Follow strict aseptic technique

- Full written consent required for post-mortem biopsy samples
- Take 2 biopsies from over scapula (as this leaves less obvious damage) as soon as possible after death, ideally before 48 hr have elapsed
- Send sample to inherited metabolic diseases laboratory immediately, or store at +4°C before dispatch for maximum of 12 hr, **do not freeze**
- Include clinical details, date and time of sampling, and date and time of death on request form

SKIN CARE● 1/2

INTRODUCTION
Neonatal skin care is very important, especially if baby is premature and/or in a critical condition. Special emphasis is placed on skin barrier properties, transcutaneous absorption, transepidermal water loss and maintaining skin integrity

PURPOSE
- Maintain integrity of the skin
- Prevent/minimise skin damage
- Minimise water loss and heat loss
- Protect against absorption of toxic materials and drugs
- Treat skin damage
- Ensure optimal healing of wounds

RISK FACTORS
- Prematurity
- Birth weight <1000 g
- Oedema
- Immobility
- Congenital skin problems
- Invasive procedures

Birth weight <1250 g
Careful handling
- Most serious injuries can occur in first hours and days after birth when baby often requires intensive care monitoring

Frequent bathing changes skin pH, disrupts protective acid mantle and is not recommended

Preventing/minimising risk of skin injury/infection in all babies
- Ensure adequate hand hygiene to protect baby's skin from cutaneous infection e.g. *Staphylococcus aureus*
- Change baby's position 4–6 hrly as condition dictates and place IV lines and monitoring leads away from skin
- Check all substances that come into contact with baby's skin. Avoid using those with potential percutaneous absorption
- Protect areas of skin from friction injury with soft bedding and supporting blanket rolls
- Use pressure-relief mattresses (e.g. Spenco®)
- Change nappy 4–6 hrly as condition dictates. Wash nappy area with warm water and dry well
- Nurse baby, especially extremely-low-birth-weight, in humidity of 60–90% to protect skin, maintain body temperature and prevent water loss. Wean humidity as appropriate with increasing gestational age/day of life
- Use ECG leads with caution on babies <26 weeks' gestation

Disinfectants
- Disinfect skin surfaces before invasive procedures, e.g. IV cannulation, umbilical vessel catheterisation, chest drain insertion, IV puncture or heel pricks for laboratory samples
- Use disinfectant pre-injection as per unit policy

Adhesives
- In all newborns, use adhesives sparingly to secure life support, monitoring and other devices
- Wherever possible, use Duoderm® under adhesive tape; adheres to skin without the use of adhesive and will prevent epidermal stripping
- Remove adhesives carefully with warm water on a cotton wool ball. Alcohol is very drying, easily absorbed and should be avoided

CORD CARE
Immediate
- Clean cord and surrounding skin surface as needed with cleanser used for initial or routine bathing and rinse thoroughly or cleanse with sterile water
- Clean umbilical cord with warm water and cotton wool and keep dry

Ongoing

- Keep cord area clean and dry. If cord becomes soiled with urine or stool, cleanse area with water
- Educate staff and families about normal mechanism of cord healing
- Teach parents or care-givers to keep area clean and dry, avoid contamination with urine and stool, keep nappy folded away from area and wash hands before handling baby's umbilical cord area

NAPPY DERMATITIS

To maintain optimal skin environment

- Change nappy frequently
- Use nappy made from absorbent gel materials
- Use cotton wool and warm water. **Do not** use commercially available baby wipes
- Encourage/support breastfeeding throughout infancy

Prevention strategies for babies at risk

- Use petrolatum-based lubricants or barriers containing zinc oxide
- Avoid use of products not currently recommended for newborns (e.g. polymer barrier films)

Treat significant skin excoriation

- Identify and treat underlying cause
- Protect injured skin with thick application of barrier containing zinc oxide

Presence of red satellite lesions/culture indicates *Candida albicans* nappy rash

- Rash will become more intense if covered by occlusive ointments. Treatment includes antifungal ointments or cream and exposure to air and light
- Do not use powders in treatment of nappy dermatitis
- Avoid use of antibiotic ointments

STOMA MANAGEMENT (GASTROINTESTINAL)● 1/4

TYPES OF STOMA

Fig. 1: Split stoma and mucous fistula

Split stoma and mucous fistula

- Bowel is divided and both ends brought out through abdominal wall separately
- Proximal end is the functioning stoma and distal end is the mucous fistula
- Operation note should make it clear where the stoma and mucous fistula are situated on the abdomen
- Stoma and mucous fistula may sometimes be fashioned side-by-side without a skin bridge. The wound is closed with dissolvable sutures

Fig. 2: End stoma without mucous fistula

End stoma without mucous fistula

- Proximal bowel end is brought out through abdominal wall as stoma and distal end is closed and left within the abdominal cavity

Fig 3: Loop stoma (slightly prolapsed)

Loop stoma

- Formed by suturing a loop of bowel to the abdominal wall and making an opening into bowel, which remains in continuity

MANAGEMENT

Application of stoma bag

- Before stoma starts working, fit an appropriately sized stoma bag and empty 4–6 hrly
- In a split stoma and mucous fistula, fit the stoma bag on the proximal stoma only, where possible, and leave muc0us fistula exposed and dressed with a paraffin gauze dressing (e.g. Jelonet) or Vaseline® and non-sterile gauze dressing
- Change bag every 1–3 days (maximum) or if it leaks
- Remove using a stoma adhesive remover wipe
- Clean skin around stoma with warm tap water and dry with non-sterile gauze

Monitoring

- Examine baby's abdomen and stoma daily
- Look for:
- dehydration
- abdominal distension
- wound infection or breakdown
- peri-stomal skin excoriation
- granulation tissue formation
- stomal bleeding
- discolouration of stoma or mucous fistula
- stomal prolapse or retraction
- stoma bag leakage

- rectal discharge
- If stoma becomes dusky or black, call the surgical team
- If skin surrounding the stoma is excoriated, identify cause and treat

Weight

- Babies with small bowel stoma: measure and record weight 2–3 times/week
- Inadequate weight gain or weight loss may be secondary to:
- insufficient calorie intake
- malabsorption
- dehydration (high stoma output)
- electrolyte abnormalities (high stoma output)

Stoma effluent

- Maintain a regularly updated fluid balance chart and record:
- fluid intake and stoma losses
- colour and consistency of stoma effluent

Serum electrolytes

- Measure at least every 2 days in the first 7 post-operative days

Urinary electrolytes (sodium and potassium)

- Not useful if baby on diuretics (result may be falsely high)
- Monitoring is extremely important for nutrition and growth
- Measure weekly
- Babies with stoma (especially small bowel stoma) are at risk of losing a significant amount of sodium into the effluent. They will often fail to gain weight if total body sodium is depleted. Serum sodium is an unreliable indicator of total body sodium
- Urinary sodium and Na^+:K^+ ratio are better indicators of sodium depletion
- Sodium supplements usually required in babies with a small bowel stoma until the stoma closed
- If urinary sodium is <20 mmol/L or ratio of concentration of urinary sodium to potassium is <3:1, increase sodium intake

NUTRITION

Total parenteral nutrition and no enteral feeds

- Check surgical discharge letter and operation notes for instructions on starting enteral feeds
- Introduce enteral feeds slowly and increase gradually (see **Nutrition and enteral feeding** guideline)
- Useful indicators of potential feed intolerance are:
- vomiting and abdominal distension
- bile in nasogastric aspirates
- large nasogastric losses
- low stoma losses – indicating dysmotility/obstruction
- high stoma losses – indicating malabsorption
- reducing substances or fat globules in the stool/stoma effluent

Combination of parenteral nutrition and enteral feeds

- Increase enteral feeds gradually (see **Nutrition and enteral feeding** guideline)
- It is not possible to predict how much enteral feed baby will be able to tolerate. As a general rule, the more distal the stoma, the better the absorption of feeds
- The amount of stoma effluent and presence/absence of reducing substances or fat in the stoma effluent should guide the advancement of enteral feeds
- Do not **automatically** increase enteral feed in response to weight gain, but rather in response to stoma output volume

Full enteral feeds

- Tolerance of enteral feeds can fluctuate with time and babies with stoma are at high risk of life-threatening dehydration and electrolyte abnormalities as a result of gastroenteritis. There should be a low threshold for readmission to hospital and appropriate resuscitation

COMPLICATIONS

High stoma output

- Daily output >20 mL/kg/day in premature or low-birth-weight babies and 30 mL/kg/day in term babies
- Measure serum and urinary electrolytes
- Replace stoma losses (when >20 mL/kg/day) mL-for-mL using sodium chloride 0.9% with potassium chloride 10 mmol in 500 mL IV
- Consider either reducing or stopping enteral feeds until losses decrease, liaison with surgical team is encouraged
- Test stoma effluent for reducing substances and fat globules
- If reducing substances are positive or fat globules present, consider reduction of enteral feed or changing type of enteral feed after consultation with a surgeon, specialist surgical outreach nurse or dietitian
- Only change feeds after a detailed dietetic review
- Perform blood gas; (stoma effluent may be rich in bicarbonate and metabolic acidosis may be present; consider sodium bicarbonate supplementation)

Mucous fistula

- If present, consider recycling of stoma effluent (see **Recycling stoma losses via a mucous fistula** guideline). Before recycling, consult surgical team to decide whether a contrast study through the mucous fistula is required
- If contrast study advised, make arrangements with surgical unit and inform surgical team when the study will take place
- Surgical team will review and advise if recycling may start
- If baby not thriving, consider parenteral nutrition (see **Parenteral nutrition** guideline)

Increasing enteral feeds in a baby with poor weight gain and a high output stoma will worsen the situation

- If none of the above measures are effective, stop enteral feeds, start parenteral nutrition and consult surgical team to discuss surgical options

Stomal stenosis

- May be present if:
- stomal output reduces or stoma stops functioning
- stoma effluent becomes watery
- Call surgical team for advice

Prolapse

- Call surgical team for advice. If stoma is discoloured, emergency action required

STOMA CLOSURE

- Often aimed to be performed when baby is well and thriving, which may be after discharge from hospital
- Indications for early closure are:
- failure to achieve full enteral feeds
- recurrent stomal prolapse with/without stomal discolouration
- stomal stenosis
- high stoma output not responding to measures outlined above

DISCHARGE PLANNING AND PARENTAL TEACHING

- Discharge when baby well, tolerating feeds and thriving
- It is the responsibility of the ward/unit nurse to teach parents stoma care
- When discharge planned, inform:
- secretary of surgical consultant who fashioned the stoma to arrange outpatient follow-up
- local stoma care specialist to order stoma supplies for home and support family
- neonatal surgical outreach service (if involved in care)
- nutritional/dietetic follow-up as required

Who to call when you need help?

Surgical team

- Call team of consultant surgeon who performed the surgery
- In an emergency out-of-hours, contact on-call surgical registrar
- Stoma care specialist [e.g. Gail Fitzpatrick and Emily Hooler at BCH (mobile 07557 001653)] for management of stoma-related complications, and parent and staff training
- Neonatal surgical outreach service [e.g. Louise Lawrence (mobile 07769 367483) and Tracey Hill (mobile 07767 310846)] for advice, support and training on surgical management
- Local dietetic contact where appropriate

USEFUL INFORMATION

- https://bwc.nhs.uk/neonatal-surgical-outreach-service
- http://www.e-lfh.org.uk/programmes/paediatric-surgery/

STROKE ● 1/2

- Defined as a group of heterogenous conditions with focal disruption of cerebral flow secondary to arterial or venous thrombosis, embolisation or haemorrhagic events between 20 weeks' gestation and 28th postnatal day, and confirmed by neuroimaging studies. Includes:
  - perinatal arterial ischaemic stroke (PAIS): disruption of cerebral artery blood flow due to thrombosis, embolism, vasospasm or hypoxic-ischemic encephalopathy
  - cerebral sinovenous thrombosis (CSVT): clots within venous sinuses results in congestion, oedema and eventually venous infarction with/without haemorrhage
  - haemorrhagic infarct: results from focal accumulation of blood within brain parenchyma
  - periventricular haemorrhagic infarction: venous congestion following germinal matrix haemorrhage
- Prevalence in term and near term babies estimated 6–17 per 100,000; in preterm, estimated prevalence 1:1600–1:8000. Approximately 80% ischemic stroke and 20% CVST and haemorrhagic stroke

RISK FACTORS

Exact cause of neonatal stroke unknown but risk factors include:

Neonatal	Maternal	Prothrombotic disorders
Cardiac lesions or fetal heart rate abnormalities	Primiparity or history of infertility	Methyltetrahydrofolate reductase (MTHFR) mutation
Intrauterine growth restriction	Chorioamnionitis	Protein C deficiency
Coagulation disorder	Oligohydramnios	Protein S deficiency
Hypoxic ischaemic encephalopathy	Premature rupture of membranes	Antiphospholipid antibody
Infection	Vacuum extraction	Homocysteine defect
Trauma	Pre-eclampsia	
Metabolic conditions	Gestational diabetes	
Male sex	Coagulation disorders	
	Substance misuse (cocaine)	
	Toxins	
	Emergency section or vacuum extraction	

ACUTE PRESENTATION

- Most common presentation is seizure (typically focal) involving 1 extremity
  - occurs in 70–90% of cases
  - typically presents within first 3 days of life
- Approximately 80% of cases involve left hemisphere
- May manifest with:
  - features of encephalopathy (irritability, lethargy, increased or decreased muscle tone)
  - feeding difficulties
  - apnoeic episode
  - intraventricular haemorrhage (IVH) – CVST to be excluded in term babies with unexplained IVH

LONG-TERM PRESENTATION

- Subtle signs may not be obvious in newborn period
- As child grows, most common sign is weakness or decreased movement on one side of body
  - one-handedness or hand preference in children aged <1 yr
- Delayed/missed developmental milestones

INVESTIGATIONS

Initial investigations

- As majority of babies with stroke will present with seizure, initial investigations for stroke is similar to first line investigations for seizures (see **Seizure** guideline)
- Placental histology
- Cranial ultrasound scan (USS)
  - PAIS – typical triangular or wedge-shaped echo-density in region of middle cerebral artery may be seen but may take up to end of first week to evolve on USS
  - difficult to diagnose CVST on USS due to high false negatives
- MRI

- diffusion-weighted imaging with apparent diffusion co-efficient considered gold standard for identifying infarct in neonatal brain
- location and extent of lesions best assessed 2–4 days after onset of stroke when apparent co-efficient of diffusion reaches its nadir
- MR arteriogram or venogram
- perform acutely where thrombosis suspected

Second line investigations where stroke diagnosis strongly suspected

- Echocardiography to assess for cardiac problems, especially if:
- abnormal cardiac examination
- multifocal infarcts on USS
- Thrombophilia screen
- discuss with tertiary paediatric haematologist before conducting this
- limited utility in neonatal period due to decreased levels of proteins C and S, antithrombin, and Factor XI (30% of adult levels)
- if carried out too early in neonatal period repeat testing after 3–6 months may be required
- no longer routinely indicated in neonates except:
  - positive family history of venous thromboembolic disease – perform factor V Leiden
  - maternal history of antiphospholipid syndrome – antiphospholipid antibodies test

MANAGEMENT

- Mainstay of management is support and neuroprotection
- Admit to NNU
- Ensure ABC of resuscitation; avoid hyperventilation
- Seizure control
- see **Seizures** guideline and liaise with neurology team if necessary
- once seizures stopped aim to discontinue treatment if possible, due to long-term effects on the developing brain
- seizures rarely persist beyond neonatal period in babies with stroke
- Treat underlying infection if suspected – avoid hyperthermia
- If too unstable to feed start IV fluids
- Correct electrolyte/glycaemic derangement or dehydration (common in CSVT)
- Discuss antithrombotic agents for CSVT with tertiary paediatric haematologist (not shown to be useful in PAIS treatment)
- Referral to allied health professionals (AHP) team for neurodevelopmental assessment/screening
- If feeding and/or swallowing difficulties identified, refer to speech and language therapy for dysphagia assessment

Haemorrhagic stroke

- Correct platelet or clotting factor deficiencies if present; extra dose of vitamin K may be required
- Urgent neurosurgical discussion if confirmed on scan

LONG-TERM OUTCOMES

- Dependent on type of stroke, extent and location of infarction
- MRI has important role in predicting motor outcome especially in PAIS
- involvement of basal ganglia, cerebral hemisphere and posterior limb of internal capsule is highly predictive of contralateral spastic hemiplegic cerebral palsy
- Approximately two-thirds of children with PAIS have poor long-term outcomes, ranging from mild to severe neurologic disability. Deficits can be variable and recognised early in infancy (i.e. delayed motor milestone or early handedness, speech, language and communication difficulties), or later into childhood and adolescence. Hence these babies require long-term follow-up in neonatal clinic or with a neurologist (where available)
- Neuro-rehabilitation improves outcome – early referral to neurodevelopmental rehabilitation services (inpatient where available) and community occupational therapy, physiotherapy and speech and language therapy on discharge

SUBGALEAL HAEMORRHAGE (SGH) ● 1/3

RECOGNITION AND ASSESSMENT

Definition

- Accumulation of blood in the loose connective tissue of subgaleal space
- Damaged emissary veins connecting subgaleal space to the intracranial venous sinuses can lead to significant blood loss of up to two-thirds of circulating volume with significant morbidity and mortality (≥50% in severely affected cases)

Risk factors

Vacuum extraction

- Incorrect positioning of cup
- cup marks on sagittal suture
- leading edge of cup <3 cm from anterior fontanelle
- Prolonged extraction time (>20 min)
- >3 pulls or >2 cup detachments
- Failed vacuum extraction

Maternal factors

- Primiparous
- PROM >12 hr
- Maternal exhaustion
- Prolonged second stage
- High or mid cavity forceps delivery

Neonatal factors

- Macrosomia
- Coagulopathy (vitamin K deficiency, Factor VIII or Factor IX deficiency)
- Low-birth-weight
- Male sex
- Low Apgar scores
- Resuscitation at birth
- Cord blood acidosis
- Fetal malpresentation
- Can occur in unassisted deliveries – especially if difficult delivery

Signs

- Local signs
- generalised swelling or boggy consistency of scalp
  - not limited by sutures
  - especially at the cup site
  - fluctuant leather-like pouch filled with fluid
- elevation and displacement of ear lobes and periorbital oedema
- irritability and pain on handling
- Systemic signs
- hypovolemic shock
  - tachycardia
  - tachypnoea
  - dropping haematocrit
  - increasing lactate or worsening acidosis
  - poor activity
  - pallor
  - hypotension
  - acidosis
- neurological dysfunction and seizures (late sign)
- ischaemic end organ damage to liver or kidneys
  - can manifest as worsening liver and renal function (poor prognostic indicator)

Profound shock can occur rapidly with blood loss into subgaleal space – the blood loss may not be apparent

Investigations
- FBC and coagulation on admission
- repeat at clinical team's discretion
- Group and blood crossmatch (notify blood bank). See **Massive haemorrhage** guideline
- Venous/capillary gas including lactate and base excess, electrolytes (2–4 hrly)
- Blood glucose

DIFFERENTIAL DIAGNOSIS
- SGH: crosses suture lines
- Cephalohematoma: subperiosteal bleeding limited by suture lines
- Caput succedaneum: oedematous collection of serosanguinous fluid in the subcutaneous layer of the scalp
- has distinct borders
- does not enlarge
- not fluctuant
- Chignon: artificial caput succedaneum limited to suction cap application site

IMMEDIATE TREATMENT
Initial management
- Follow local guidelines for monitoring of newborns following vaginal operative delivery
- If SGH suspected, urgent review by tier 2 staff/consultant
- If SGH confirmed, admit to NNU immediately
- inform consultant (if not involved in assessment)
- Discuss use of pressure bandage with neurosurgeons
- Peripheral IV access
- leave indwelling for 12 hr
- Continuously monitor:
- heart rate
- respiration
- oxygen saturation
- blood pressure (non-invasively if no arterial line) ≥24 hr
- Continue to assess capillary refill and peripheral perfusion
- Regularly observe and palpate scalp swelling to assess for:
- continuing blood loss
- change in head shape or circumference
  - measure head circumference hourly for the first 6–8 hr after birth
  - take several measurements each time and record the highest
  - 1 cm increase in circumference = 40 mL blood loss
  - if pressure bandage in place, measure over the bandage
  - **interpret head circumference changes in conjunction with all other clinical parameters and not in isolation**
- change in colour
- displacement of ears
- Volume replacement:
- see **Massive haemorrhage** guideline, and **Recognition of hypovolaemia** below
- Group O RhD negative blood is immediately available on labour suite/obstetric theatres
- Monitor urine output
- Maintain blood glucose >2.6 mmol
- Repeat FBC and coagulation studies (4–6 hr after initial assessment)
- Inotropes, vasopressors, multiple packed red cell transfusions and clotting products may be required for severe cases of shock [using packs 1 and 2 (see **Massive haemorrhage** guideline)]
- Ongoing assessment for jaundice
- Discuss use of tranexamic acid with consultant

RECOGNITION OF HYPOVOLAEMIA
Signs of significant volume loss
- High/increasing heart rate (>160 bpm)
- Low/falling Hb or haematocrit

- Poor peripheral perfusion with slow central capillary refill (>3 sec)
- Low/falling blood pressure (mean arterial blood pressure <40 mmHg in term baby)
- Presence of, or worsening of, metabolic acidosis
- If available, use echocardiography to assess volume status
  - small systemic veins and low ventricular filling volumes can indicate hypovolaemia
- If any of above present, or concern of ongoing haemorrhage from scalp assessment/neurological dysfunction/evidence of renal or hepatic impairment – follow **Massive haemorrhage** guideline

Consider elective intubation and ventilation for worsening shock – but blood is the priority over airway and breathing

CONCOMITANT INJURIES

- Hypoxic ischaemic encephalopathy [see **Hypoxic ischaemic encephalopathy (HIE)** guideline]
- Brain trauma resulting in cerebral oedema and/or intracranial haemorrhage
- Subdural haematoma
- Dural tear with herniation
- Superior sagittal sinus rupture
- Pseudomeningocele and encephalocele
- Subconjunctival and retinal haemorrhage
- Elevated intracranial pressure from SGH mass effect
- Skull fractures

SUBSEQUENT MANAGEMENT

- If any of the intracranial concomitant injuries above suspected, neuroimaging to be undertaken once baby stabilised following discussion with radiologist to establish best modality
- Monitor on NNU for ≥24 hr
- Discuss with neurosurgical team

SUDDEN UNEXPECTED POSTNATAL COLLAPSE IN FIRST WEEK OF LIFE INVESTIGATIONS ● 1/3

This guideline is to be used in combination with measures to reduce the risk of postnatal collapse.
https://www.bapm.org/resources/sudden-and-unexpected-postnatal-collapse-supc

INTRODUCTION

Sudden unexpected postnatal collapse (SUPC) in apparently well term babies, in the first week of life, is rare

DEFINITION

Any term or near term (≥35 weeks' gestation) baby who is well at birth (with normal 5 min Apgar score and deemed well enough to have routine postnatal care) and collapses unexpectedly (i.e. discovered in state of cardiorespiratory compromise such that resuscitation with intermittent positive pressure ventilation is required) within the first 7 days from delivery and either dies or goes on to require intensive care

SUMMARY OF BAPM SUPC OBSERVATIONS AND RECOMMENDATIONS

- Increased likelihood of congenital anomaly or metabolic disease
- Need comprehensive investigation to determine underlying cause
- Involve interdisciplinary liaison to maximise diagnostic yield
- Senior doctor to obtain detailed family history and situational events
- Notify coroner of all babies who die from such collapse
- For all babies who die, post-mortem to be performed by a perinatal pathologist
- If collapse happened after baby left hospital, safeguarding issues must be considered
- Detailed multiprofessional case review should follow investigation of unexpected baby death

INFORMATION AFTER THE EVENT

- Collect the following as soon as possible after presentation

Parental medical history

- Full parental drug, alcohol and nicotine history
- 3-generation family tree (where available) noting egg donation, sperm donation (where relevant)

Obstetric history (from consultant obstetrician or senior trainee)

- Infection
- Fetal growth
- Suspected fetal anomalies
- Fetal movements
- Liquor volume

Labour and birth (from consultant obstetrician or senior trainee)

- Maternal medication
- Markers of fetal wellbeing
  - scalp pH
  - cord pH
  - electronic fetal monitoring
  - passage of meconium
  - requirement for resuscitation

Health of baby until collapse

- Growth and feeding

Other information

- Circumstances surrounding collapse
  - who was present?
  - was baby feeding?
  - position of baby (from staff and family present at time of collapse)
- It is also important to collect information from other agencies who may have been involved with the family e.g. primary care, social care and police
- Full resuscitation details

INVESTIGATIONS

Maternal

- Placenta: as soon as possible after birth, send both fixed and fresh samples of placenta and cord (where available) for pathology and microbiology
- Maternal blood: Kleihauer, viral titres (serum to be frozen for acute phase titres), toxicology
- Maternal high and low vaginal swabs

Investigations whilst baby alive

- Carry out a full examination
- Liaison with local and regional laboratories is mandatory to ensure optimal collection and timing of samples. Use your judgment about which tests to prioritise to ensure optimal diagnostic yield with least intervention
- If baby sufficiently stable, consider transfer to a specialist unit for imaging

Neonatal blood

- FBC
- Coagulation
- Renal and liver biochemistry
- Glucose
- Lactate
- Calcium
- Magnesium
- Ammonia
- Beta-hydroxybutyrate
- Amino acids
- Insulin
- Free fatty acids
- Acylcarnitines profile
- Urates
- Uric acid
- Cortisol (3 samples at different times)
- Culture
- Viral titres
- Blood spot for cardiolipin analysis
- Specific genetics:
- DNA
- chromosomes
- microarray
- retained bloodspot

Cerebrospinal fluid

- Biochemistry
- Glucose paired with blood glucose
- Culture
- Virology
- Lactate
- Amino acids (including glycine storage)

Surface swabs

- Bacteriology

Nasopharyngeal aspirate

- Bacteriology and virology

Urine

- Bacteriology
- Virology
- Toxicology
- Organic acids (including orotic acid)
- Amino acids (including urinary sulphocysteine)
- Retain urine for storage

Imaging

- Skeletal survey
- Cranial ultrasound scan
- MRI brain scan
- Renal/adrenal ultrasound scan
- Electrocardiogram
- Echocardiogram

Other investigations

- Ophthalmoscopy/Retcam
- Skin biopsy for fibroblast culture
- If unable to exclude neuromuscular or mitochondrial disorder, muscle biopsy
- Electro-encephalogram
- Genetics assessment and clinical photographs
- If suspicion event may have been due to unrecognised hypoventilation/apnoea, send DNA sample for PHOX2B gene abnormalities (commonly implicated in congenital central hypoventilation syndrome)
- Consider testing for mutations and copy number variation in MECP2 gene – may present as newborn encephalopathy and/or apnoeas and respiratory collapse
- Array-based comparative genomic hybridisation is a useful investigation (will replace conventional karyotyping for detecting causative chromosomal deletions and duplications)

Investigations before post-mortem

- If it has not been possible to take samples during life, take samples (where feasible) while awaiting post-mortem to prevent degradation of material and loss of important diagnostic information. Where possible, discuss and agree baseline samples with a pathologist and, where indicated, a biochemist
- if difficulty obtaining necessary kit for investigations, most labour wards have a 'stillbirth kit' which will contain much, if not all, of what is needed. Discuss with laboratory before beginning procedure if a full kit cannot be collected
- Throat and nose swabs for bacterial and viral culture
- Blood culture
- Blood and urine for metabolic studies
- glucose, acylcarnitine, organic and amino acids including orotic acid and sulphocysteine, freeze urine for storage
- Blood for DNA, chromosomes and dried bloodspots on several cards
- CSF obtained by lumbar puncture or ventricular tap – biochemistry
- glucose
- culture
- virology
- lactate
- amino acids including glycine, freeze and store
- Skin biopsy (if possible locally) for culture and storage of fibroblasts: 3 × 2 mm full thickness using aseptic technique into culture or viral transport medium or gauze soaked in sodium chloride 0.9%. Send promptly to cytogenetics laboratory (see **Skin biopsy** guideline)
- Muscle biopsy (if possible locally) for electron microscopy, histopathology and enzymology. Wrap in aluminium foil, snap freeze and store at −70°C. Contact metabolic physician or pathologist before sample collection

SAFEGUARDING ISSUES

- Must be considered in all cases of out of hospital collapse
- The process of investigation for unexpected child deaths sometimes needs following even if baby survives
- Involves the rapid response team from the district who need to undertake a home visit to gather additional information regarding the critical event

SUPRAVENTRICULAR TACHYCARDIA ● 1/3

INTRODUCTION

- Supraventricular tachycardia (SVT) is the most common pathological tachycardia in newborns – can be new presentation or commenced in fetal life

RECOGNITION AND ASSESSMENT

- Sustained, accelerated non-sinus rhythm, regular and narrow-complex, originating above the level of the atrioventricular (AV) junction
- Heart rate >200 bpm
- May be 1 of 3 tachycardias:
  - atrial
  - atrioventricular nodal re-entry (AVNRT)
  - atrioventricular re-entrant (AVRT) – most common SVT in fetal and neonatal life
- Can be presenting feature of a congenital heart defect – but do not wait to exclude this before commencing treatment

SIGNS

- Can be variable with some common presentations:
  - acute onset in a baby in heart failure/shock with no previous signs and symptoms
  - fetal tachycardia during pregnancy
  - baby with irritability, poor feeding, sweating and breathlessness for hours/days before presentation
- SVT can cause reduced cardiac output due to reduced diastolic filling time
  - many babies tolerate SVT well, however if tachycardia is sustained for >6 hr signs of congestive heart failure may develop, with irritability, tachypnoea and pallor

CAUSES

- No known cause in majority of babies
- Idiopathic SVT is more common in neonates than older children
- Wolf-Parkinson-White pre-excitation – only becomes visible after conversion to sinus rhythm
- Congenital heart defect, including Ebstein's and TGA

TRIGGERS

- Co-existing infections e.g. LRTI
- Manage all triggers appropriately

EXAMINATION

- Heart rate: >200 bpm
- Capillary refill
- Blood pressure
- Respiratory rate, may be normal/abnormal depending on:
  - signs of heart failure
  - co-existing respiratory conditions
  - infections
- SpO_2 may be normal, low, or of poor signal in haemodynamic compromise
- Cardiovascular and respiratory examination; may be normal aside from fast heart rate
- Examine baby for other reasons of tachycardia, including pain and environmental factors e.g. pyrexia (particularly in premature baby in incubator)

INVESTIGATIONS

- 12-lead ECG to confirm SVT diagnosis in haemodynamically stable cases
  - if baby haemodynamically unstable, or if ECG not available, defibrillator can record and print rhythm strips from 3 different leads
- Once SVT terminated, perform repeat ECG to assist with identification of pre-excitation and any other underlying rhythm abnormality
- Blood gas for:
  - acid-base balance
  - electrolytes
  - ionised calcium
- Echocardiogram to assess structural anatomy and cardiac function

SUPRAVENTRICULAR TACHYCARDIA ● 2/3

MANAGEMENT

Contact cardiology and KIDS NTS team as soon as baby deemed unstable

If haemodynamic compromise:

Is there circulatory shock
- Defibrillator
- Anaesthetic support

Shock present

ABCDE approach

Synchronous DC shock 1 J/kg

Ongoing SVT

Synchronous DC shock 2 J/kg

Ongoing SVT

Consider amiodarone IV and discuss with KIDS NTS for conference call with paediatric cardiology

SVT terminated

Discuss with KIDS NTS for conference call with paediatric cardiology for further management

While arranging cardioversion consider:
- Try vagal manoeuvres
- Obtain IV access (central or large peripheral vein)
- Trial of adenosine 100–300 microgram/kg IV (up to 500 microgram/kg in presence of experienced clinician)

If no haemodynamic compromise:

Shock not present

- Vagal manoeuvres
- Obtain IV access
- Rhythm strip recording

Consider using adenosine 100 microgram/kg and increase to 500 microgram/kg in presence of experienced clinician

Adenosine 100 microgram/kg IV
Wait 2 min
SVT terminated?

Yes

No

Adenosine 200 microgram/kg IV
Wait 2 min
SVT terminated?

Yes

No

Adenosine 300 microgram/kg IV
Wait 2 min
SVT terminated?

Yes

No

- Discuss further medical management and cardioversion with paediatric cardiology
- If haemodynamically stable and still in SVT at 6 hr consider transfer to regional centre

Sinus rhythm

- Discuss with paediatric cardiology for prophylactic medication
- if SVT recurs despite prophylactic medication transfer to regional centre

ADDITIONAL INFORMATION

Adenosine

- Give via cannula into large vein in upper limb, followed by rapid sodium chloride 0.9% flush; very short half-life of 10–30 sec – must get to the heart as quickly as possible
- Acts by slowing conduction time through the AV node
- Intraosseous access ineffective due to time taken for venous return
- Use 3-way tap with Luer-lock syringes; 1 syringe for adenosine and 1 for sodium chloride 0.9% flush

Never test cannula by aspirating blood into syringe with adenosine before injection – will lead to breakdown of adenosine
Major route of elimination via active take-up by red blood cells and vascular endothelial cells where it is metabolised

- Keep defibrillator nearby
- Capture and print rhythm, while adenosine given, via defibrillator rhythm strip or ECG recording
- Starting dose 100 microgram/kg, repeat after 2 min, if no effect increase to maximum dose of 300 microgram/kg as in flowchart above
- if experienced clinician present, maximum dose 500 microgram/kg

Vagal manoeuvres

- Cold stimulation of the trigeminal nerve (afferent branches) leads to stimulation of the vagus nerve (efferent branches); slows AV node conduction
- wrap bag of ice in towel and apply to baby's face or
- wrap baby in towel and immerse entire head in ice-cold water for 5 sec
- Unilateral carotid massage not recommended – difficult to perform in neonates and has limited effect

DC cardioversion

- Applies direct current of electricity to the heart, synchronised to R wave of QRS complex on ECG
- less risk of inducing ventricular fibrillation than unsynchronised
- Ideally carry out under general anaesthetic, or at least sedation
- If performed outside NNU, will require anaesthetic support
- Synchronised shock starting at 1 J/kg, if no response increase to 2 J/kg as in flowchart above

Chemical cardioversion:

- Discuss with paediatric cardiology if:
- haemodynamically unstable and unresponsive to adenosine IV or DC cardioversion
- haemodynamically stable and unresponsive to adenosine IV
- If SVT occurred in-utero consult perinatal plan and discuss with paediatric cardiology

Prophylactic medication

- When SVT has terminated, it is vital to commence medication to prevent further episodes
- Choice of prophylactic medication based on:
- previous history of SVT (including in fetal life)
- assessment of ECG, both in SVT and once terminated
- cardiac function
- Discuss with paediatric cardiology centre and send ECG/echocardiogram for review

FOLLOW-UP

- Any episode of SVT – follow-up with paediatrician with expertise in cardiology/paediatric cardiologist
- Arrange:
- baseline echocardiogram in outpatient clinic (if not already done)
- Holter monitor

SURFACTANT REPLACEMENT THERAPY – INCLUDING LESS INVASIVE SURFACTANT ADMINISTRATION (LISA) TECHNIQUE ● 1/3

- Early administration of natural surfactant decreases the risk of acute pulmonary injury and neonatal mortality
- Early CPAP and selective administration of surfactant is preferable to routine intubation and prophylactic surfactant
- Rescue surfactant to be given early in the course of RDS
- Administer natural (animal-derived) surfactants
- Poractant alfa (Curosurf®) at 200 mg/kg shows survival advantage compared to beractant or poractant alfa in a dose of 100 mg/kg
- LISA (less invasive surfactant administration) technique is preferred method of surfactant administration for spontaneously breathing babies on CPAP – reduces the need for mechanical ventilation, incidence of BPD, and incidence of pneumothorax (see **LISA** section below)

INDICATIONS

Babies born <30 weeks' gestation

- **Routine intubation of these babies solely for the purpose of administration of surfactant is not recommended, and a policy of early CPAP with selective surfactant administration is preferred**
- If requiring intubation for respiratory support during resuscitation or stabilisation or if mother has not had antenatal steroids, give surfactant in delivery room once ETT position confirmed through chest movement, auscultation and CO_2 detector
- Otherwise, institute early CPAP and administer surfactant if worsening RDS, e.g.
- rapidly increasing oxygen requirements
- FiO_2 >0.3 on CPAP pressure ≥6 cm of H_2O
- increased work of breathing

Babies born ≤33 weeks' gestation who are not ventilated

- Use LISA technique to give surfactant if FiO_2 >0.30 on CPAP pressure ≥6 cm of H_2O and increased work of breathing
- if LISA cannot be undertaken, endotracheal surfactant administration followed by early extubation should be used

Other babies that can be considered for surfactant therapy (after discussion with consultant)

- Ventilated babies with meconium aspiration syndrome (may need repeat dose after 6–8 hr)
- Term babies with pneumonia and less compliant lungs

EQUIPMENT

- Natural surfactant, poractant alfa (Curosurf®) 200 mg/kg (2.5 mL/kg) round to the nearest whole vial (prophylaxis and rescue doses can differ)
- Sterile gloves
- TrachCare Mac™ catheter (do not cut NGT) or specific surfactant administration set

PROCEDURE

Preparation

- Calculate dose of surfactant required and warm to room temperature
- Ensure correct endotracheal tube (ETT) position
- check ETT length at lips
- listen for bilateral air entry and look for chest movement
- if in doubt, ensure ETT in trachea using laryngoscope and adjust to ensure bilateral equal air entry
- chest X-ray not essential before first dose
- Refer to manufacturer's guidelines and **Neonatal Formulary**
- Invert surfactant vial gently several times, without shaking, to resuspend the material
- Draw up required dose
- Administer via TrachCare Mac™ catheter or specific surfactant administration pack

Instillation

- With baby supine, instil prescribed dose down ETT
- Wait for recovery of air entry/chest movement and oxygenation between boluses

SURFACTANT REPLACEMENT THERAPY – INCLUDING LESS INVASIVE SURFACTANT ADMINISTRATION (LISA) TECHNIQUE ● 2/3

Post-instillation care

- Do not suction ETT for 8 hr following instillation of surfactant
- Be ready to adjust ventilator/oxygen settings in response to changes in chest movement, tidal volume and oxygen saturation. Use of volume-targeted ventilation can facilitate responsiveness to rapid changes in lung compliance following surfactant instillation. Be ready to reduce FiO_2 soon after administration of surfactant to avoid hyperoxia
- Arterial/capillary blood gas within 30 min

SUBSEQUENT MANAGEMENT

- If baby has ongoing evidence of RDS, e.g. remains ventilated with FiO_2 >0.3 with mean airway pressure >7 cm H_2O and other problems have been excluded, give further dose of surfactant 6–12 hr after first dose
- Third dose should be given only at request of attending consultant

DOCUMENTATION

- For every dose given, document in case notes:
- indication for surfactant use
- time of administration
- dose given
- condition of baby pre-administration, including measurement of blood gas unless on labour ward when SpO_2 should be noted
- response to surfactant, including measurement of post-administration blood gas and SpO_2
- reason(s) why second dose not given, if applicable
- reason(s) for giving third dose if administered
- Prescribe surfactant on drug chart

LISA

Definition

- Method using a thin catheter to deliver surfactant in spontaneously breathing preterm infant with respiratory distress syndrome receiving non-invasive ventilator support
- continue non-invasive ventilator support during procedure

Indication

- Suspected surfactant deficiency leading to respiratory distress syndrome on non-invasive respiratory support as evidenced by:
- rapidly increasing oxygen requirements
- FiO_2 >0.3 on CPAP pressure ≥6 cm of H_2O
- increased work of breathing [exclude pneumothorax by transillumination of chest (see **Transillumination of the chest** guideline)]
- ≤33 weeks' gestation
- aged <48 hr

Exclusion

- Persistent/worsening respiratory acidosis despite optimal non-invasive ventilation

Equipment

- Laryngoscope/video laryngoscope
- Suction
- Sterile gloves
- LISA catheter – Surfcath™ (Vygon)
- Surfactant, and syringe and needle to draw up surfactant

Drugs

- Fentanyl 700 nanograms/kg IV (awake sedation)
- Atropine 20 microgram/kg IV
- Naloxone 100 microgram/kg IV (if poor respiratory effort after procedure)

Emergency equipment

- Bag/valve/mask/T-piece

- Oxygen and air
- Stethoscope
- ETTs

Procedure

- Determine and document indication for LISA
- Ensure baby is loaded with caffeine or is already on maintenance caffeine (spontaneous breathing extremely important for LISA)
- Inform parents (if present)
- Ensure venous access (peripheral cannula)
- Ensure team of 3 for procedure (including at least 1 nurse and 1 doctor)
- Draw up surfactant 200 mg/kg
- Attach T-piece to end of syringe with Luer-lock system
- Wash hands
- Use sterile gloves
- Place baby supine, ensuring incubator doors do not limit movement of laryngoscope
- Minimise heat loss
  - if necessary, increase incubator temperature, use blankets, swaddling and transwarmer
- Baby will remain on non-invasive ventilation support (CPAP/HFNC) during procedure – have naso-/orogastric tube (N/OGT) *in situ* to help identify oesophagus
- Prepare semi-rigid Surfcath™ by manually bending to desired angle
- Administer sedation: atropine and fentanyl IV
- Visualise vocal cords using laryngoscope/video laryngoscope (some gentle cricoid pressure may be necessary)
- Insert Surfcath™ with concavity of distal tip following the natural orientation of the airway
- Advance Surfcath™ until the 2 cm black tip disappears below the vocal cords
- Remove laryngoscope, keeping Surfcath™ in place
- Use finger to close mouth around Surfcath™, ensuring no pressure applied to soft tissue. Note catheter marking at baby's lip (see **Table**)
- Maintain Surfcath™ in midline during procedure

Table

Gestational age (weeks)	Current weight (kg)	Surfcath™ length at lips (cm)
23–24	0.5–0.6	5.5
25–26	0.7–0.8	6.0
27–29	0.9–1.0	6.5
30–31	1.1–1.4	7.0
32–33	1.5–1.8	7.5

This is not an emergency procedure.
Stop if you are having difficulty and consider alternatives

- Connect surfactant syringe to Surfcath™
- Ask helper to administer surfactant in 4 aliquots very slowly (with gaps of 30 sec over 3–5 min), to avoid surfactant coming back up
- Aspirate the N/OGT after each aliquot of surfactant to confirm that surfactant has not been instilled into the stomach. If this occurs, stop administering surfactant and reassess position of Surfcath™
- After final aliquot of surfactant inject ≥0.2 mL air into Surfcath™ to clear any remaining surfactant
- Remove Surfcath™ and ensure baby clinically stable with normal cardiorespiratory parameters before repositioning baby and closing incubator
- Following procedure, document:
  - procedure
  - how well tolerated
  - FiO_2

SYPHILIS – BABIES BORN TO MOTHERS WITH POSITIVE SEROLOGY ● 1/3

INTRODUCTION

- If maternal syphilis serology positive on booking bloods check British Association of Sexual Health and HIV (BASHH) syphilis infant birth plan – see https://www.bashh.org/resources/25/updated_guideline_syphilis_2024

RECOGNITION AND ASSESSMENT

- **No risk**
  - assessed by genitourinary medicine (GUM)
  - past infection with documentation of previous adequate treatment (with appropriate beta-lactam antibiotic)
- **Low risk**
  - mother adequately treated with appropriate beta-lactam antibiotic during this pregnancy >4 weeks prior to delivery
- **High risk**
  - mother:
    - treated <4 weeks before delivery **or**
    - treated with non-beta-lactam regimen **or**
    - untreated/inadequately treated or inadequately reported

CLINICAL FEATURES

General	• Low birth weight • Prematurity • Non-immune hydrops • Pyrexia
Haematological	• Generalised lymphadenopathy • Hepatosplenomegaly • Jaundice • Anaemia (can be haemolytic) • Thrombocytopenia
Skin	• Rash (usually maculo-papular, may be a blueberry muffin rash, but almost any form of rash is possible) • Palms and soles may be red, mottled and swollen • Vesiculobullous lesion • Condylomata lata (flat, wart-like plaques in moist areas such as the perineum) • Perioral fissures • Severe desquamation, often of hands/feet
Mucous membranes	• Haemorrhagic rhinitis (bloody snuffles) • Ulceration of the nasal mucosa • Mucous patches
Neurological	• Meningitis • Microcephaly • Hydrocephaly • Intracranial calcification • Sensorineural deafness • Failure to move an extremity (pseudo-paralysis of Parrot)
Ophthalmic	• Cataracts • Corneal scarring • Glaucoma • Chorioretinitis • Microphthalmia
Skeletal	• Osteochondritis • Periostitis (elbows, knees, wrists)
Liver	• Hepatosplenomegaly • Jaundice (may be conjugated) • Hepatitis
Other	• Multi-organ failure • Glomerulonephritis • Pneumonitis

SYPHILIS – BABIES BORN TO MOTHERS WITH POSITIVE SEROLOGY ● 2/3

INVESTIGATIONS

No risk

- **No** investigations

Low risk

- Maternal blood sample for syphilis serology to be taken on admission
- Send venous blood for infant syphilis serology (treponemal antibody/RPR/IgM)
  - check with local laboratory regarding volume needed
  - ask to prioritise RPR
  - do not use infant cord blood
- Examine baby:
  - if normal, can be discharged with follow up blood tests at 3 months
  - if lesions or signs of congenital syphilis, follow 'high risk' pathway

High risk

- Take blood samples as mentioned in 'low risk' section
- Congenital syphilis likely if:
  - clinical features suggestive of congenital syphilis
  - low risk with RPR ≥ 4x maternal RPR or positive CSF RPR test or positive treponemal IgM
- If lesions present, consult local GUM and specialist paediatric services
  - carry out dark ground microscopy and/or PCR of exudates or body fluids, e.g. nasal discharge (direct demonstration of *T. pallidum*)
  - send throat swab or nasopharyngeal aspirate for PCR
- Full blood count, blood film, liver function, electrolytes, creatinine, lactate, bone chemistry
- CSF: cells, protein, RPR, treponemal antibody
- Urine: test for blood/protein
- X-rays of 4 limb long bones
- Ophthalmic assessment
- Audiology
- If physical signs present test for other congenital infections: HIV, hepatitis, HSV etc. (SCORTCH https://adc.bmj.com/content/106/2/117)

TREATMENT

- If high risk, start treatment from birth, no need to wait for serology results
- Benzylpenicillin 25 mg/kg IV (**BNFc**) for 10 days
  - aged <7 days 12-hrly
  - aged 7–28 days 8-hrly
  - aged >28 days: 6-hrly
- If ≥24 hour's dosing missed, restart treatment as Treponema can rapidly regrow
- Repeat LP at 6 months if CSF white cells/protein raised or CSF RPR positive/TPHA >1:320
- Positive antenatal screening treponemal serology and cases of possible/confirmed congenital syphilis to be notified to Integrated Screening Outcomes Surveillance Service (ISOSS)
- Report cases of congenital syphilis as a serious incident

SYPHILIS – BABIES BORN TO MOTHERS WITH POSITIVE SEROLOGY ● 3/3

FOLLOW-UP

Aged (months)	Baby not treated for syphilis	Baby treated for syphilis at birth
3	RPR and treponemal IgM • If RPR and IgM negative: discharge • If RPR titre falling but still positive: repeat at 6 months • If RPR titre unchanged from birth, or rising, or IgM positive: discuss with local paediatric infection specialists or GUM	RPR and treponemal IgM • If RPR falling: review at 6 months • If RPR unchanged from birth, or rising, or IgM positive: discuss with local paediatric infection specialists or GUM
6	RPR • If RPR negative: discharge • If RPR titre falling but still positive: repeat at 12 months • If RPR titre unchanged from previously or rising: discuss with local paediatric infection specialists or consult GUM	RPR • If RPR falling: review at 12 months • If RPR unchanged from previously or rising: discuss with local paediatric infection specialists or GUM • Babies treated with a positive CSF to also have follow-up CSF after 6 months
12	RPR • If RPR negative: discharge • If RPR positive: discuss with local paediatric infection specialists or GUM	RPR • If RPR has achieved sustained 4x drop from peak level: discharge • If RPR remains higher: discuss with local paediatric infection specialists or GUM

TEMPERATURE MANAGEMENT AND PREVENTION OF HYPOTHERMIA ● 1/4

This guideline does not apply to babies receiving therapeutic hypothermia

MEASUREMENT AND RECORDING

- Use axillary route
- Measure temperature on admission, within ≤60 min of birth, then
- Hourly until stable, then 3–4 hrly
- more frequently if required due to clinical condition
- 6-hrly when baby stable and on 3-hrly feeds
- Babies with poor perfusion (or on medical request) – monitor core peripheral temperature difference continuously using temperature probes on chest and foot
- difference of >2°C suggestive of poor perfusion

TEMPERATURE RANGES

- Normal: 36.5–37.5°C
- Hypothermia: <36.5°C
- Low grade fever: 37.6–37.9°C
- Fever: ≥38°C

ASSESSMENT

- Hypothermia, fever and temperature instability can be signs of serious illness
- If baby unwell, irrespective of body temperature, notify medical staff/ANNP
- Beware of unusual temperature behaviours e.g.:
- hypothermia in term baby
- fever in preterm baby

HYPOTHERMIA

Follow BAPM QI Toolkit for prevention of hypothermia in preterm babies − https://www.bapm.org/pages/105-normothermia-toolkit

Risks and consequences

- Babies <32 weeks' gestation, low-birth-weight, small-for-dates and sick babies are at particular risk of hypothermia
- Adverse effects associated with hypothermia include:
- hypoglycaemia
- hypoxia and metabolic acidosis
- respiratory distress and chronic lung disease
- necrotising enterocolitis
- intraventricular haemorrhage
- late onset sepsis
- death

PREVENTION

Delivery suite

- Keep room 23–28°C and free from draughts, especially when delivery imminent
- Aim for room temperature on the higher side for all premature babies (particularly IUGR)
- Pre-warm resuscitaire and towels with heater at 100%

Babies <32 weeks

- Place baby on resuscitaire, dry head only
- place baby's body in plastic bag
- place hat on baby's head
- Take temperature before moving baby to NNU
- Transfer to NNU with suitable thermal support

Other babies

- Use pre-warmed towels. Dry immediately, discard towel and wrap in another towel and blanket
- Ensure room warm enough to enable skin-to-skin contact and early breastfeeding
- Cover exposed skin with warm blanket
- Avoid giving bath immediately after birth

TEMPERATURE MANAGEMENT AND PREVENTION OF HYPOTHERMIA ● 2/4

Neonatal unit

- Keep at 22–26°C to avoid cooling from radiant heat loss, and 'misting' (condensation) in incubators
- Keep incubators and cots away from windows to prevent radiation heat loss
- Nurse babies requiring intensive care in pre-warmed incubator
- For very premature babies, use humidification in incubator
- If respiratory support e.g. high flow oxygen therapy, CPAP or ventilation anticipated, ensure humidifiers are turned on and set temperature of 37°C
- Do not leave incubator portals open for longer than necessary
- Avoid excessive wrapping/clothing of babies in cots

Incubator temperature during first 3 days

Birth weight (g)	Incubator temperature (°C)
1000	35
1500	34
2000	33.5
2500	33.2
3000	33
4000	32.5

- Babies <1000 g may require higher temperatures, occasionally >37°C
- If baby's temperature remains within normal limits for 24 hr, reduce incubator temperature according to baby's needs
- When baby's weight reaches approximately 1600 g, transfer to open cot

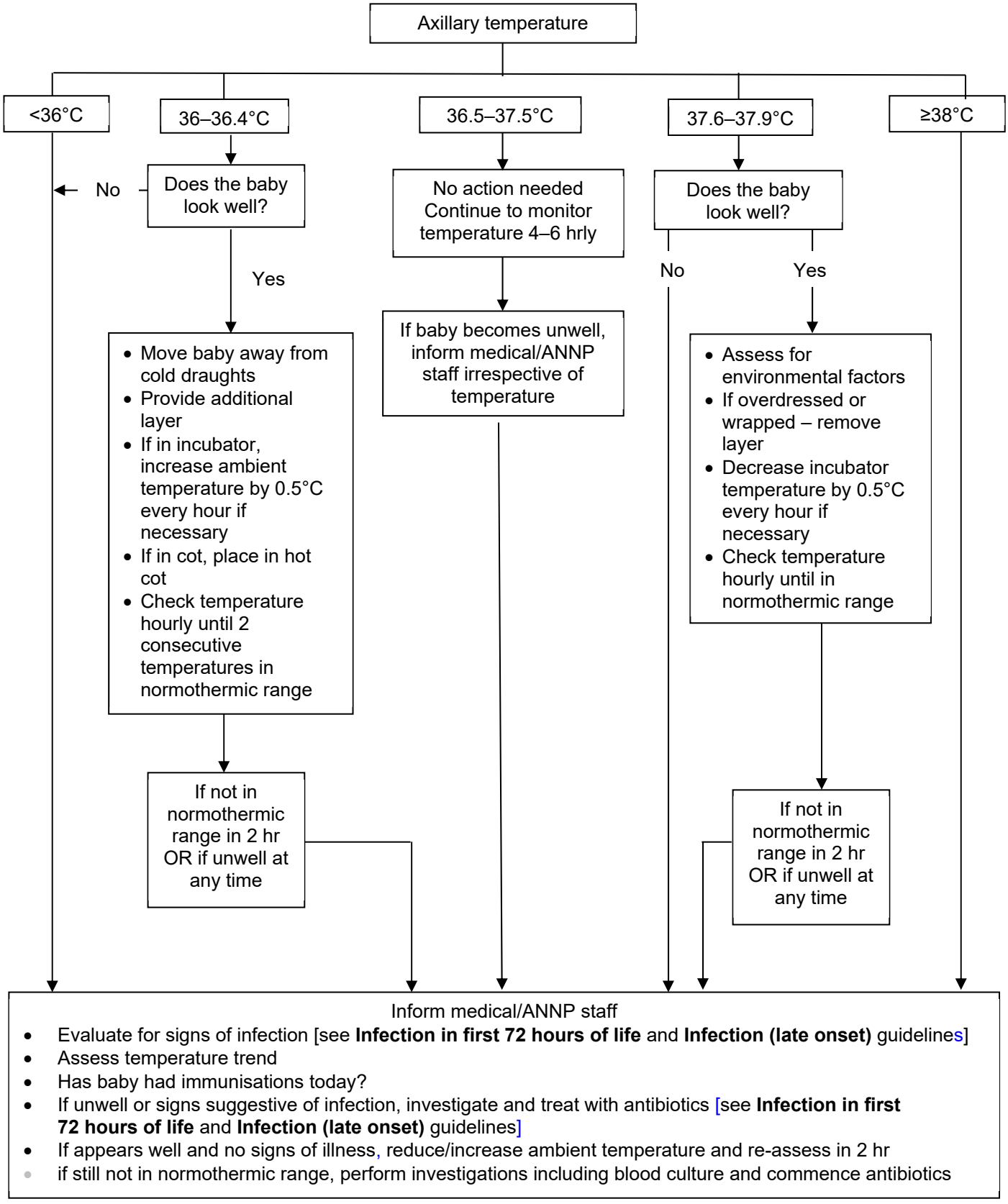
Rainout may occur if the difference between temperature in incubator and room temperature is >5°C: ensure room temperature kept at 22–26°C

Babies not at risk of hypothermia

- If not requiring observation of respiratory status or invasive procedures, babies may be dressed, wrapped and placed in a cot

Take care not to overheat babies. Aim for 36.5–37.5°C

EVALUATION AND MANAGEMENT OF TEMPERATURE INSTABILITY


Axillary temperature
<36°C
36–36.4°C
36.5–37.5°C
37.6–37.9°C
≥38°C
No
Does the baby look well?
Yes
No action needed
Continue to monitor temperature 4–6 hrly
Does the baby look well?
No
Yes
• Move baby away from cold draughts
• Provide additional layer
• If in incubator, increase ambient temperature by 0.5°C every hour if necessary
• If in cot, place in hot cot
• Check temperature hourly until 2 consecutive temperatures in normothermic range
If baby becomes unwell, inform medical/ANNP staff irrespective of temperature
• Assess for environmental factors
• If overdressed or wrapped – remove layer
• Decrease incubator temperature by 0.5°C every hour if necessary
• Check temperature hourly until in normothermic range
If not in normothermic range in 2 hr OR if unwell at any time
If not in normothermic range in 2 hr OR if unwell at any time
Inform medical/ANNP staff
• Evaluate for signs of infection [see Infection in first 72 hours of life and Infection (late onset) guidelines]
• Assess temperature trend
• Has baby had immunisations today?
• If unwell or signs suggestive of infection, investigate and treat with antibiotics [see Infection in first 72 hours of life and Infection (late onset) guidelines]
• If appears well and no signs of illness, reduce/increase ambient temperature and re-assess in 2 hr
• if still not in normothermic range, perform investigations including blood culture and commence antibiotics

TEMPERATURE MANAGEMENT AND PREVENTION OF HYPOTHERMIA ● 4/4

MANAGEMENT OF HYPOTHERMIA

- Mild hypothermia can be managed with the addition of:
- hat
- heated mattress
- If baby's temperature <36.0°C, ensure baby is well and hypothermia is not a manifestation of illness
- In a well hypothermic baby, consider:
- use of incubator, if available
- increasing humidity, if appropriate for gestational age
- bubble wrap
- skin-to-skin
- Recheck temperature in 1 hr
- Baby to be reviewed by medical team

REWARMING OF HYPOTHERMIC BABIES

- Rewarm in incubator
- ≥1200 g, rewarm at 1°C/hr
- <1200 g, rewarm more slowly

CAUTION DURING USE OF TRANSWARMERS

- **Heated pads (Transwarmer) should not be used if another heat source (incubator heater, radiant heater, heated mattress etc.) is already in use**
- If units choose to use Transwarmers in conjunction with other heat sources to prevent newborn hypothermia, strict vigilance must be given to:
- ensuring skin integrity
- avoiding hyperthermia by continuous temperature monitoring
- limiting duration of use

THROMBOCYTOPENIA ● 1/4

DEFINITION

- Platelet count <150 × 10^9/L
- mild (platelet count 100–150 × 10^9/L) and moderate (50–100 × 10^9/L) thrombocytopenia occur frequently in preterm babies who are ill, and in those born to women with pregnancy-induced hypertension (PIH)
- severe thrombocytopenia (<50 × 10^9/L) is uncommon, particularly in apparently healthy term babies and raises the possibility of neonatal allo-immune thrombocytopenia (NAIT, see below)
- ensure results are not spurious, if in doubt repeat venous sample

CAUSES

	WELL	ILL
Common	• Placental insufficiency • IUGR • Maternal diabetes • Immune mediated • NAIT • Autoimmune (maternal ITP, SLE) • Trisomies (13, 18, 21) • Congenital infections	• Infection • Necrotising enterocolitis (NEC) • Disseminated intravascular coagulation (DIC) • Hypoxic ischaemic encephalopathy • Congenital infections • Thrombosis (renal, aortic) • Congenital leukaemia or neuroblastoma
Rare	• Inherited disorders • Thrombocytopenia absent radius (TAR) syndrome • Congenital amegakaryocytic thrombocytopenia (CAMT) • Cavernous haemangioma (Kasabach-Merritt syndrome) • Congenital thrombotic thrombocytopenia purpura (TTP)	• Metabolic disorders (propionic and methylmalonic acidaemia)

Severe thrombocytopenia in an otherwise healthy term newborn baby is NAIT until proved otherwise

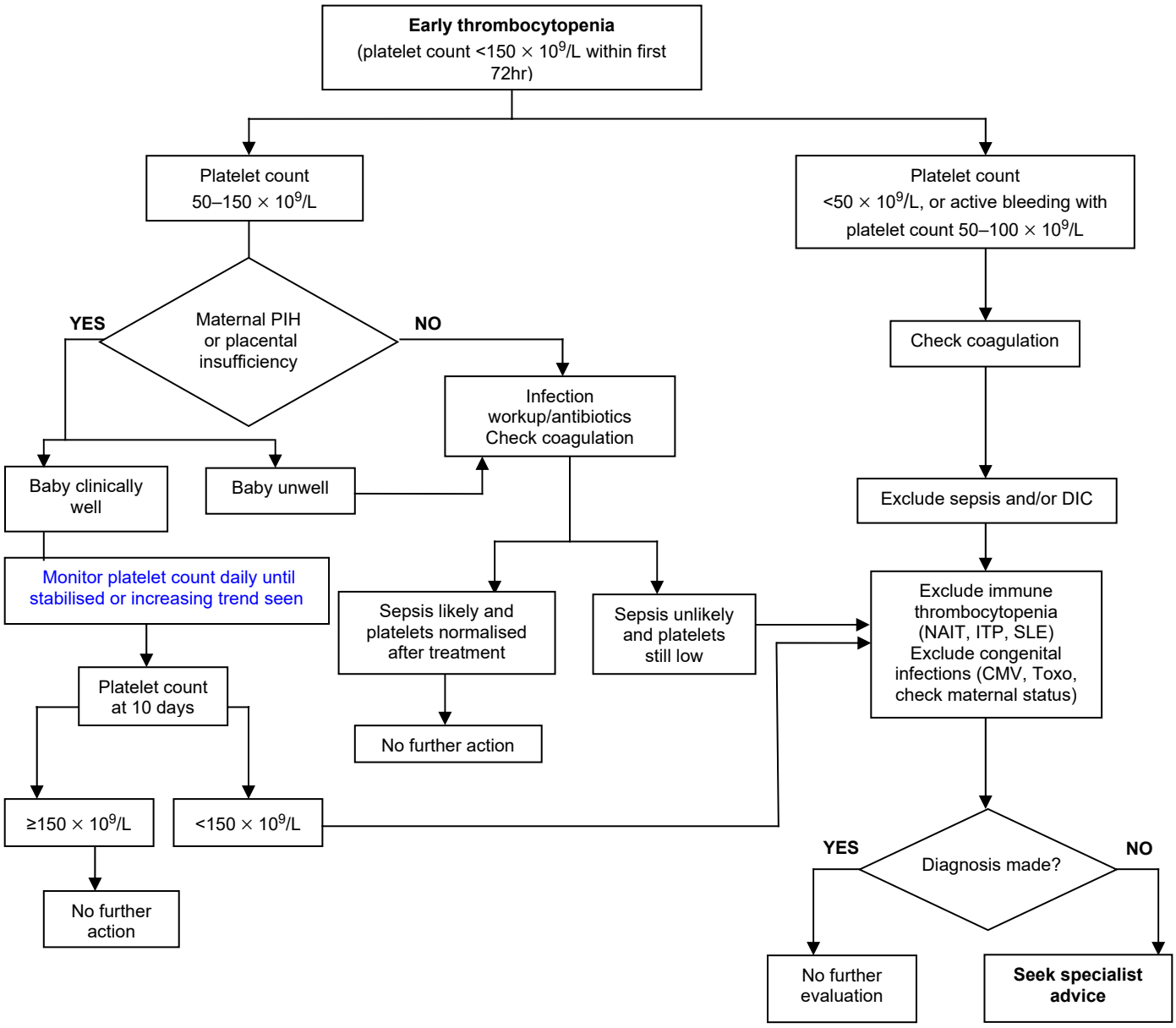
ASSESSMENT

- **Evaluation of early-onset (<72 hr after birth) thrombocytopenia (see Flowchart)**
- preterm babies with early-onset mild-to-moderate thrombocytopenia in whom there is good evidence of placental insufficiency: further investigations not warranted unless platelet count does not recover within 10–14 days
- preterm babies without placental insufficiency: investigate first for sepsis
- term babies: investigate for sepsis and NAIT
- If severe thrombocytopenia, perform clotting screen
- Look for presence of active bleeding or visible petechiae
- If features suggestive of congenital infection (e.g. abnormal LFT, rashes, maternal history etc.) or if persistent or unexplained thrombocytopenia, perform congenital infection i.e. CMV and toxoplasma serology, check maternal status for syphilis, rubella and HIV, herpes simplex and enteroviral screen
- Ensure urine sample sent for CMV. Check with local microbiology department to ensure correct sample bottles sent
- Obstetric history, particularly maternal platelet count, drugs, pre-eclampsia. Family history of bleeding disorders
- Careful examination, include other associated features (e.g. trisomies and inherited syndromes)

Evaluation of late onset thrombocytopenia

- Thrombocytopenia presenting in baby after first 3 days of life, presume underlying sepsis or NEC until proved otherwise
- these babies are at significant risk of haemorrhage, though the benefit of platelet transfusion is not clear-cut

Summary of investigations (also refer to text above)


Early thrombocytopenia
(platelet count <150 × 10⁹/L within first 72hr)
Platelet count 50–150 × 10⁹/L
Platelet count <50 × 10⁹/L, or active bleeding with platelet count 50–100 × 10⁹/L
YES
Maternal PIH or placental insufficiency
NO
Check coagulation
Infection workup/antibiotics Check coagulation
Baby clinically well
Baby unwell
Exclude sepsis and/or DIC
Monitor platelet count daily until stabilised or increasing trend seen
Sepsis likely and platelets normalised after treatment
Sepsis unlikely and platelets still low
Exclude immune thrombocytopenia (NAIT, ITP, SLE) Exclude congenital infections (CMV, Toxo, check maternal status)
Platelet count at 10 days
No further action
≥150 × 10⁹/L
<150 × 10⁹/L
YES
Diagnosis made?
NO
No further action
No further evaluation
Seek specialist advice

MANAGEMENT

General

Avoid

- Heel prick and IM injections, use venepuncture and IV injections
- Invasive procedure (central line, LP, chest drain etc.). If any of above are unavoidable:
- discuss with on-call consultant
- give platelet transfusion if platelet count <50 × 10^9/L before the procedure (if semi-elective e.g. LP, central lines) **or** during/soon after procedure (if emergency e.g. chest drain)
- give particular attention to haemostasis

Platelet transfusion

- Only available for immediate and specific therapy for thrombocytopenia but carries risk of transfusion-related infections and transfusion reactions, and only after discussion with consultant

Indications for platelet transfusion (term and preterm babies)

- Main objective is to prevent consequences of severe thrombocytopenia, significant risk of acute intracerebral haemorrhage and neuromorbidity

Platelet count <25 × 10^9/L
- In otherwise well baby, including NAIT

Platelet count <50 × 10^9/L
- In baby with:
- clinical instability
- concurrent coagulopathy
- birth weight <1000 g and aged <1 week
- previous major bleeding e.g. intraventricular haemorrhage (IVH)
- current minor bleeding (e.g. petechiae, venepuncture oozing)
- planned surgery, exchange transfusion or invasive procedure (central line insertion, LP, chest drain, ECMO etc.)
- platelet count falling and likely to fall below 30
- NAIT if previously affected sibling with intracranial bleed
- PDA treated with indomethacin or ibuprofen

Platelet count <100 × 10^9/L
- If major bleeding or major surgery (e.g. neurosurgery), give platelet transfusion

Type of platelets
- NAIT: HPA compatible platelets wherever possible
- All others: blood group-compatible CMV negative
- Irradiation of platelets is not routinely required but consider for babies with definite or suspected immunodeficiency, or those who have undergone intrauterine transfusions

Volume of platelets
- 10–20 mL/kg (10 mL/kg usually raise platelet count by >50 × 10^9/L). Babies with suspected NAIT will require higher dose of 20 mL/kg

ADMINISTRATION OF PLATELETS

Never administer platelets through an arterial line or UAC

- Use platelets as soon as they arrive on ward (ensure IV access before requesting platelets from blood bank)
- Keep platelets at room temperature
- To minimise loss, draw contents of pack into 50 mL syringe through a special platelet or fresh blood transfusion set with a 170–200 micrometre filter and infuse using a narrow bore extension set linked to IV line, primed with sodium chloride 0.9%
- Transfuse platelets over 30–60 min, mixing syringe from time to time to avoid platelets settling down
- There is no need for routine use of diuretic after platelet transfusion
- Check platelet count within 12 hr after transfusion

NAIT
- Analogous to rhesus haemolytic disease and caused by transplacental passage of maternal alloantibodies directed against fetal platelet antigens, inherited from father but absent in mother
- Majority caused by antibodies against platelet antigens, HPA-1a (80%) and HPA-5b (10–15%)
- NAIT can affect first pregnancy and has 10% risk of severe intracranial haemorrhage; 20% of survivors exhibit significant neurodevelopmental sequelae

Recognition
- For HPA-1a antigen-negative women, complete a neonatal alert form
- Petechiae, purpura, excessive bleeding and severe thrombocytopenia in an otherwise healthy term newborn baby indicate NAIT until proved otherwise
- NAIT can also present with:
- fetal intracranial haemorrhage or unexplained hydrocephalus
- postnatal intracranial haemorrhage in term baby

If NAIT suspected, involve consultant neonatologist immediately

Assessment

- Check baby's platelet count daily until >100 × 10^9/L
- Check mother's platelet count (may already be in maternal healthcare record)
- Obtain blood from mother, baby and father for platelet typing and antibodies. Liaise with haematology department about appropriate samples
- Arrange cranial ultrasound scan (see **Cranial ultrasound scans** guideline)

Treatment

- In 30% of cases, maternal antibody may not be found and can be detected later
- Transfuse baby with suspected NAIT with accredited HPA-1a antigen-negative platelets if:
- bleeding **or**
- platelet count <25 × 10^9/L
- National Blood Service has a pool of suitable donors, and platelets are available at short notice from blood bank
- if accredited HPA-1a negative platelets not available, administer random donor platelets

Inform blood bank and consultant haematologist as soon as NAIT suspected.
Do not delay transfusion for investigations

- If thrombocytopenia severe (<50 × 10^9/L), or haemorrhage persists despite transfusion of antigen-negative platelets, administer intravenous human immunoglobulin (IVIG) 1 g/kg/day once daily (for 1–3 days (may require additional doses 2–4 weeks later)
- Aim to keep platelet count >25 × 10^9/L for first week of life, or as long as active bleeding continues
- Report newly diagnosed babies with NAIT to fetal medicine consultant for counselling for future pregnancies

NEONATAL AUTOIMMUNE THROMBOCYTOPENIA

Clinical features

- Caused by transplacental passage of autoantibodies in women with ITP or SLE, and affecting about 10% of babies born to such women
- Severity generally related to severity of maternal disease
- Risk of intracranial haemorrhage in baby <1%

Management

- Report all women with thrombocytopenia and those splenectomised through Neonatal Alert System, and instigate plan of management
- Send cord blood for platelet count
- Check baby's platelet count 24 hr later, irrespective of cord blood result
- If baby thrombocytopenic, check platelet count daily for first 3–4 days or until >100 × 10^9/L
- If platelet count <25 × 10^9/L, whether bleeding or not, treat with IVIG (dose as in NAIT) +/-steroids
- Discharge baby when platelet count >100 × 10^9/L
- For babies requiring IVIG, recheck platelet count 2 weeks later. A few may require another course of IVIG at this time because of persistence of maternal antibodies

THYROID DISEASE (MANAGEMENT OF BABIES BORN TO MOTHERS WITH THYROID DISEASE) ● 1/3

RECOGNITION AND ASSESSMENT

- Obstetric team should inform neonatal team after delivery of a baby with maternal history of hyperthyroidism (Graves' disease) or hypothyroidism

MATERNAL HYPERTHYROIDISM

Common

- Maternal Graves' disease (autoimmune hyperthyroidism)
- IgG thyroid stimulating antibodies cross from mother with Graves' disease to fetus towards the end of approximately 1 in 8 pregnancies
- half-life of thyroid stimulating antibodies is approximately 12 days and resolution of fetal thyrotoxicosis corresponds to their degradation over 3–12 weeks

Rare

- Maternal Hashimoto's thyroiditis producing thyroid stimulating antibodies
- Activating mutations of TSH receptor (family history of hyperthyroidism in first degree relatives)

Babies at high risk

- Mother has high levels of thyroid antibodies [thyroid stimulating immunoglobulin (TSI) or thyroid receptor antibody (TRAb)] – refer to maternal healthcare record
- Maternal thyroid antibody status unknown
- Mother clinically hyperthyroid or receiving antithyroid drugs in third trimester
- Mother previously treated with radioactive iodine or surgery or with previously affected babies
- Evidence of fetal hyperthyroidism
- Family history of TSH receptor mutation

Clinical features of fetal hyperthyroidism

- Usually present by aged 24–48 hr but can be delayed up to 10 days. Disorder is self-limiting over 3–12 weeks, although there may be some longer-term neurological defects
- **Head and neck**
- goitre, periorbital oedema, exophthalmos
- **Central nervous system (CNS)**
- irritability, jitteriness, poor sleeping, microcephaly
- **Cardiovascular system (CVS)**
- tachycardia, arrhythmias, flushing, sweating, hypertension
- **Gastrointestinal (GI)**
- diarrhoea, vomiting, excess weight loss, hepatosplenomegaly
- **Others**
- bruising, petechiae due to thrombocytopenia, jaundice

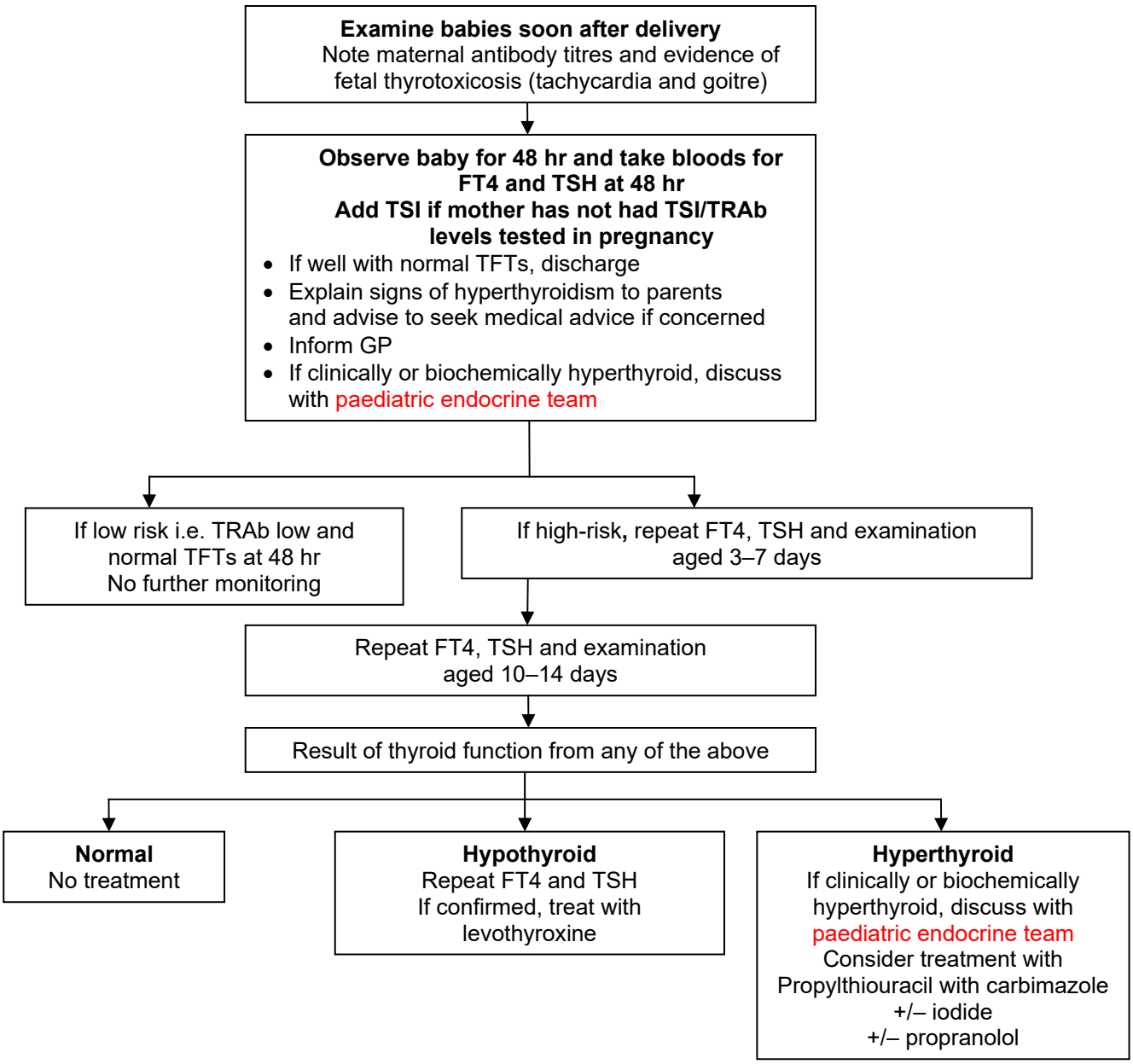
It is not sufficient to judge risk based on current maternal thyroid function as mothers on antithyroid medication or who have received thyroid ablative therapy (surgery or radioactive iodine) may be euthyroid or hypothyroid yet still have high thyroid antibody titres

Management

- Follow **Management** flowchart
- Examine high-risk babies after delivery
- note maternal antibody titres and evidence of fetal thyrotoxicosis (tachycardia and goitre)
- Observe baby for 48 hr and take bloods for FT4 and TSH at 48 hr
- if well with normal TFTs, (see **Hypothyroidism** guideline for normal values) discharge
- Explain signs of hyperthyroidism to parents and advise to seek medical advice if concerned
- If baby high risk, repeat TFTs at 3–7 days and arrange review at 10–14 days to repeat TFTs and clinical assessment
- If low risk, i.e. TRAb levels low, if TFTs normal at 48 hr no further repeats needed
- If at any stage clinically or biochemically hyperthyroid, discuss with paediatric endocrine team

THYROID DISEASE (MANAGEMENT OF BABIES BORN TO MOTHERS WITH THYROID DISEASE) ● 2/3

Flowchart: Management of babies at risk for congenital hyperthyroidism


Examine babies soon after delivery
Note maternal antibody titres and evidence of fetal thyrotoxicosis (tachycardia and goitre)
Observe baby for 48 hr and take bloods for FT4 and TSH at 48 hr
Add TSI if mother has not had TSI/TRAb levels tested in pregnancy
If well with normal TFTs, discharge
Explain signs of hyperthyroidism to parents and advise to seek medical advice if concerned
Inform GP
If clinically or biochemically hyperthyroid, discuss with paediatric endocrine team
If low risk i.e. TRAb low and normal TFTs at 48 hr
No further monitoring
If high-risk, repeat FT4, TSH and examination aged 3–7 days
Repeat FT4, TSH and examination aged 10–14 days
Result of thyroid function from any of the above
Normal
No treatment
Hypothyroid
Repeat FT4 and TSH
If confirmed, treat with levothyroxine
Hyperthyroid
If clinically or biochemically hyperthyroid, discuss with paediatric endocrine team
Consider treatment with
Propylthiouracil with carbimazole
+/– iodide
+/– propranolol

MATERNAL HYPOTHYROIDISM

Physiology

- After onset of fetal thyroid secretion at mid-gestation, maternal transfer of T4 continues to contribute to fetal serum T4, protecting neurodevelopment until birth. Prompt treatment of maternal hypothyroidism should mitigate negative effects on baby's neurodevelopment

Risks associated with maternal hypothyroidism

- Preterm delivery
- Intrauterine growth restriction
- Postpartum bleeding
- Untreated severe hypothyroidism in mother can lead to impaired brain development in baby

Management

- Hashimoto's thyroiditis (autoimmune) occurs in approximately 2.5% of women and is associated with thyroid inhibiting or, rarely, thyroid stimulating antibodies. Baby may develop transient hypo or, rarely, hyperthyroidism. These babies should be reviewed at 10–14 days and have their T4/TSH checked
- Babies born to mothers with congenital hypothyroidism (aplasia/hypoplasia) and treated with levothyroxine do not require routine thyroid function testing

THYROID DISEASE (MANAGEMENT OF BABIES BORN TO MOTHERS WITH THYROID DISEASE) ● 3/3

- Mothers who have been treated for Graves' disease (surgery or radioactive iodine) may be euthyroid or hypothyroid but may still have high thyroid antibody. Treat as high risk for neonatal hyperthyroidism and follow guideline for maternal hyperthyroidism

Breastfeeding

- Encourage for all babies even if mother currently taking carbimazole, propylthiouracil or levothyroxine
- **note:** radioactive iodine treatment is a contraindication (breastfeeding to be avoided for 6 months after radioactive iodine treatment)

TRANSCUTANEOUS CO_2 AND O_2 ● 1/3

Adapted with permission, Guy's and St Thomas' NHS Trust nursing guideline

INTRODUCTION

- In babies requiring assisted ventilation, it is essential to monitor arterial partial pressure of oxygen (PaO_2) and carbon dioxide ($PaCO_2$) to ensure adequate gas exchange
- Transcutaneous monitoring allows continuous measurement ($TcCO_2$ and TcO_2)
- Use this guideline to set up and safely use transcutaneous monitoring equipment

Clinical indications

- Monitoring adequacy of arterial oxygenation and/or ventilation
- Nursing critically ill or unstable baby

Advantages

- Reduction in number of blood gas measurements
- Immediate recognition of need for ventilation adjustment

Potential problems

- Tissue injury (e.g. erythema, blisters, burns, and skin tears) as a result of failure to change site frequently enough (2–3 hrly)
- Inadequate measurement resulting from incorrect set-up

EQUIPMENT

- Transducer: insert at end position of rack for easy accessibility
- Membranes
- Electrolyte solution
- Adhesive fixation rings
- Recalibration machine

Probe placement and application of fixation rings

- Avoid bony surfaces: use soft tissues (e.g. abdomen, buttock, thigh) and avoid placing over liver as this can prevent accurate clinical assessment of liver size
- Ensure chosen site is clean and dry
- Peel adhesive protection layer off ring
- Place ring on chosen site pressing gently on centre of ring before running finger around outside. Ensure effective seal as this will affect accuracy of measurement
- Place 3 drops of contact fluid in centre of ring
- Remove transducer from module into ring and turn 1-quarter clockwise to secure

CARE AND MONITORING

Temperature setting

- Keep transducer setting at 44°C for all babies. There is good correlation of TcO_2 with heat settings of 44°C, but lower settings will result with under-reading of TcO_2 and difference is larger with increasing TcO_2

Alarm settings

PPHN

- Exact limits will depend on specific pathology but, for guidance, in term babies with PPHN:
- TcO_2 upper 10.0 lower 5.5
- $TcCO_2$ upper 7.0 lower 5.0

Blood gas sampling

- Take blood gas 20 min after commencing transcutaneous monitoring to allow comparison between transcutaneous values and arterial partial pressures of O_2 and CO_2 levels, as discrepancy can occur
- If transcutaneous monitoring values change suddenly, check contact is in place before making ventilator changes. If any doubt about accuracy of values, check blood gas before making ventilator changes

Changing measurement site

- Babies <29 weeks: change 2-hrly
- Babies ≥29 weeks: change 3-hrly

- Unscrew transducer before removing fixation rings
- Remove fixation rings when repositioning baby from supine to prone and vice-versa to avoid pressure sore from lying on rings
- Remove rings 12-hrly on babies <29 weeks and 24-hrly on babies ≥29 weeks

Calibration of membrane
- See **Figure 1–5**

Indications
- Transducer membrane has been replaced
- Monitor displays 'calibration required'
- Measurement values in doubt
- Applying to a new baby
- Changing measurement site

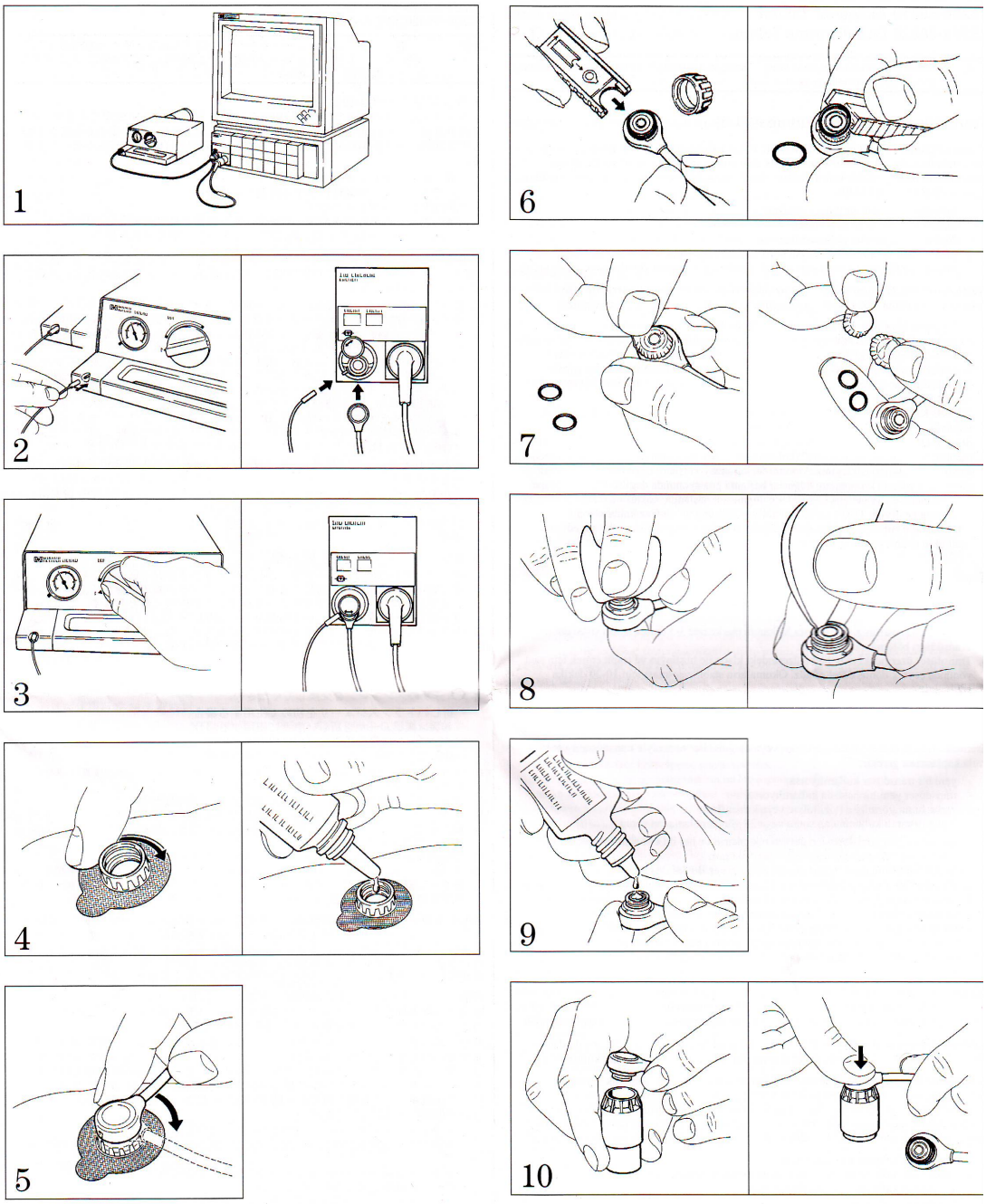
Ensure calibrator turned off after use. Do not dispose of connecting tube.
Contact technicians when calibrating gas empty

Changing transducer membranes – **see *Figure 6–10***
- All staff responsible for ventilated babies can change transducer membranes

Indications
- When using a new transducer or if transducer has dried out
- For each new baby
- When membrane crinkled, scratched or damaged
- After 5 days continuous use

Procedure
- Wash and dry hands
- To remove O-rings, unscrew protective cap from transducer and hook O-ring remover under them
- Remove both clear plastic membranes with your fingers
- To ensure correct values, clean transducer head, including groove and rim, with absorbent paper to remove all old electrolyte solution
- Apply approximately 2 drops of electrolyte solution to transducer head
- Press transducer head downward into an unused membrane replacer until replacer reacts as far as it can and a click is heard

Figure: 1–5: Calibration of membrane; **Figure: 6–10 Changing transducer membranes**



CE This product complies with the requirements of the Council Directive 93/42/EEC June 1993 (Medical Device Directive).

For USA
United States law restricts this device to sale by or on the order of a physician.

TRANSFUSION OF RED BLOOD CELLS ● 1/3

INDICATIONS

- **Acute blood loss** with haemodynamic compromise or ≥10% blood volume loss (e.g. significant feto-maternal transfusion, pulmonary haemorrhage or subgaleal haemorrhage)
  - transfuse 10 mL/kg over 30 min
  - further transfusion based on haemoglobin (Hb)
- **Top-up blood transfusion**, if Hb below threshold levels quoted in the following situations

Baby	Hb (g/L)		
Postnatal age	Suggested transfusion threshold Hb (g/L)		
	Ventilated	Non-invasive respiratory support (CPAP/BiPAP HFNC/O_2)	No respiratory support
First 24 hr	<120	<120	<100
Day 2–7 (1st week)	<120	<100	
Day 8–14 (2nd week)	<100	<85 <95 if symptomatic* or poor reticulocyte response†	
Day 15 onwards	<100	<75 <85 if symptomatic* or poor reticulocyte response	

Adapted from British Committee for Standards in Haematology recommendations 2016

* e.g. poor weight gain or significant apnoeas
† <4% or count <100 x 10^9g/L

PRE-TRANSFUSION

Communication

- If clinical condition permits before transfusion, inform parents that baby will receive blood transfusion
  - document discussion
- If parents refuse transfusion (e.g. Jehovah's Witness) follow local policy

Crossmatch

- For top-up transfusions in well baby, arrange with blood bank during normal working hours
- Crossmatch against maternal serum (or neonatal serum if maternal serum not available) for first 4 months
- For first transfusion, send samples of baby's and mother's blood

Direct Coombs testing

- Laboratory will perform direct Coombs test (DCT) on maternal serum for any atypical antibodies
- If maternal DCT negative, blood issued will be crossmatched **once** against maternal serum. No further maternal blood samples are necessary for repeat top-up transfusions
- If maternal DCT positive, crossmatching of donor red blood cells against maternal serum is required **every time**

Multiple transfusions

- In babies <29 weeks who may need multiple transfusions, use paediatric satellite packs ('paedipacks') from 1 donor (if available) to reduce multiple donor exposure

When to use irradiated blood

- Irradiated blood **must** always be given for those:
  - who have received intra-uterine transfusion
  - with suspected or proven immunodeficiency
  - receiving blood from a first- or second-degree relative, or an HLA-selected donor

When to use CMV-seronegative blood

- As CMV seronegativity cannot be guaranteed in untested blood, **use only CMV-seronegative blood for neonatal transfusions**
  - blood products in use in the UK are leucodepleted to <5 × 10^6 leucocytes/unit at point of manufacture

Special considerations

Iron supplements

- Commence oral iron supplementation in eligible babies from aged 2 weeks and when tolerating 100 mL/kg/day enteral feeds (see **Nutrition and enteral feeding** guideline)

Withholding feeds during transfusion

- Some units withhold enteral feeds during transfusion whilst others continue – there is insufficient evidence for clear recommendation

Babies with necrotising enterocolitis (NEC)

- Transfuse using red cells in sodium chloride 0.9%, adenine, glucose and mannitol (SAG-M), preferably, as it is relatively plasma-free. This may not be available in all units
- Any unexpected haemolysis associated with transfusion in a baby with NEC should be investigated for T-cell activation in consultation with local haematology department and with close involvement of consultant neonatologist

Exchange transfusion

- See **Exchange transfusion** guideline

TRANSFUSION

Volume of transfusion

- Give 15 mL/kg of red cell transfusion for babies who are not actively bleeding irrespective of pre-transfusion Hb
- Give 20 mL/kg of red cell transfusion in case of massive haemorrhage (see **Massive haemorrhage** guideline)

A paediatric pack contains approximately 50 mL blood. Use 1 pack if possible

Rate of administration

- Administer blood at 15 mL/kg over 3–4 hr
- Increase rate in presence of active haemorrhage with shock (see **Massive haemorrhage** and **Subgaleal haemorrhage** guidelines)
- Via peripheral venous or umbilical venous line (**not** via long line/arterial line)

Use of furosemide

- Routine use **not** recommended
- Consider soon after blood transfusion for babies:
  - with chronic lung disease
  - with haemodynamically significant PDA
  - in heart failure
  - with oedema or fluid overload

DOCUMENTATION AND GOOD PRACTICE

- Clearly document indication for transfusion and consent in the notes
- Ensure positive identification of baby using accessible identification
- Ensure blood transfusion volume and rate is prescribed in appropriate infusion chart
- Observations, including:
  - continuous ECG
  - SpO_2
  - hourly temperature and BP (recorded before, during and after transfusion)
- Appropriate labelling of syringes to ensure compliance with current best practice
- Unless clinically urgent, avoid transfusion out-of-hours
- To reduce need for blood transfusion, minimise blood sampling in babies (micro-techniques, non-invasive monitoring) and avoid unnecessary testing
- Delay cord clamping in accordance with the resuscitation council guidelines (see **Resuscitation** guideline)
- Ensure donor exposure is minimised by using satellite packs from same donor
- After transfusion, record benefit (or lack thereof)
- Document pre- and post-transfusion Hb levels

Hazards of transfusion

- Most important are:
- infections – bacterial/viral
- hypocalcaemia
- volume overload
- citrate toxicity
- rebound hypoglycaemia (following high glucose levels in additive solutions)
- thrombocytopenia after exchange transfusion

INDICATION

- Suspected pneumothorax (e.g. any deterioration in clinical condition, particularly if ventilated)

EQUIPMENT

- Cold light source
- Black drapes to cover incubator

PROCEDURE

- Dim lights
- Expose baby's chest and abdomen
- Remove all non-essential monitoring leads
- Cover outside of incubator with black drapes
- Place cold light tip perpendicular to and touching baby's skin
- Shine light from the side, comparing right side with left (5th position shines through the liver and is used as a control)
- Clean cold light tip with an alcohol wipe after use

DIAGNOSIS

- Pneumothorax confirmed if chest shines bright red
- Compare both sides of chest (babies can have bilateral pneumothoraces)
- Compare degree of brightness with that seen over liver
- liver and lung without pneumothorax will shine dull dark red

Caution – false positive diagnoses may be made in extremely preterm babies and those with pulmonary interstitial emphysema
Transillumination may be unreliable in babies with increased thickness of the chest wall (macrosomic term babies and those with chest wall oedema)

ACTION

- If baby is unstable or haemodynamically compromised, once pneumothorax is confirmed on transillumination, perform immediate needle thoracocentesis in 2nd intercostal space, midclavicular line on the side of the chest that shone brightly. **Do not** wait for a chest X-ray

TRANSPORT AND RETRIEVAL ● 1/4

(KIDS NTS guideline)

INTRODUCTION

The aim of a safe transfer policy is to ensure the highest standard, streamlined care. In the majority of cases transfer will be performed by a dedicated transfer team, but in certain cases the referring team may perform the transfer. In all cases the ACCEPT model (**Table 1**) can be used

INDICATIONS FOR TRANSFER

- Uplift for services not provided at referring unit (including diagnostic and drive-through transfers)
- Repatriation
- Resources/capacity

Table 1: ACCEPT model

A	**A**ssessment
C	**C**ontrol
C	**C**ommunication
E	**E**valuation
P	**P**reparation and packaging
T	**T**ransportation

ASSESSMENT

- Key questions are:
- what is the problem?
- what is being done?
- what effect is it having?
- what is needed now?

CONTROL

- Following initial assessment control the situation:
- who is the team leader?
- what tasks need to be done (clinical care/equipment and resources)?
- who will do them (allocated by team leader)?
- who will transfer baby (if relevant)?

CLINICAL CARE

- Preparation for transport begins with the referring team as soon as decision is made to transfer baby, even if being performed by another team

Airway/breathing

- If baby unstable or on CPAP with FiO_2 >0.4 and rising, intubate and ventilate
- Adjust ETT and lines depending on chest X-ray position; document all positions and adjustments and consider if repeat X-ray required; secure all lines and tubes
- If indicated, give surfactant [see **Surfactant replacement therapy – including less invasive surfactant administration (LISA) technique** guideline]
- If present, connect chest drains to a flutter valve
- If ventilated perform blood gas and adjust ventilation settings as necessary
- if non-invasive ventilation support, have recent (<6 hr) gas result available
- KIDS NTS can transfer babies on any mode of ventilation – baby **MUST** be suitable for transfer

Circulation

- If baby dependent on drug infusions (e.g. inotropes, prostaglandin), 2 reliable points of venous access must be available
- if baby receiving bicarbonate, insulin or inotropes insert double lumen UVC (**NOTE**: this only counts as 1 reliable point of venous access)
- check all access is patent and visible; ensure types and position of lines documented
- optimise blood pressure (see **Hypotension** guideline)
- ensure recent lactate result available
- ensure arterial line has BP transducer

Drugs
- Antibiotics [see **Infection in first 72 hours of life** guideline and **Infection (late onset)** guideline]
- Decide whether infusions need to be concentrated
- Check vitamin K IM has been given
- Decide whether sedation/paralysis needed for transfer
- Ensure all drug syringes are labelled

Environment
- Monitor temperature throughout stabilisation
- Cooling babies [see **Hypoxic ischaemic encephalopathy (HIE) including preparation for active cooling** guideline]

Fluids
- Ensure all fluids and infusions are in 50 mL syringes and are labelled
- Change PN to maintenance fluids
- Volume as per **Intravenous fluid therapy** guideline
- Monitor intake and output

Infection
- Check if any colonisation issues and inform receiving unit

Parents
- Update with plan of care
- Discuss how parents will get to receiving unit – may be appropriate to travel with team
- Clarify method of feeding
- Document any safeguarding issues and handover directly to receiving unit

COMMUNICATION

Referring centre
- Make decision to transfer with parents' agreement; in exceptional circumstances this may not be achievable
- For neonatal uplift transfers referrer will locate neonatal cot and then call 0300 200 1100 to refer for transfer
- for Birmingham Children's Hospital PICU beds call 0300 200 1100 for conference call about neonatal transfer and cot location
- for speciality or other PICU bed, call receiving clinician directly then call 0300 200 1100 to refer for transfer
- for all other transfers, including transfer into regional children's hospital, referrer to confirm cot availability then call 0300 200 1100 to refer for transfer
- All transfers, provide:
- demographics to administrator
- clinical details to transfer team
  - history and clinical details
  - urgency of transfer
  - interventions, investigations and results
  - medications
- Document advice given/received
- Prepare transfer information/discharge summary and arrange for images to be reviewed at receiving hospital
- Obtain sample of mother's blood (if required)
- Identify whether appropriate for parent to transfer with baby

Receiving centre
- Ensure consultant and nurse co-ordinator accept referral and agree with advice given; handover must be between receiving and referring units

EVALUATION
- Referring clinician, transfer team and receiving team evaluate urgency of transfer and decide who will do it
- Neonatal transfers are classified as:

- time critical (e.g. gastroschisis, ventilated tracheoesophageal fistula, intestinal perforation, duct-dependent cardiac lesion not responding to prostaglandin infusion and other unstable conditions)
- to be performed within 1 hr
- to be performed within 24 hr
- to be performed after 24 hr
- In the event of transfer team being unable to respond within an appropriate time period and an alternative transfer team cannot mobilise, referring unit may decide to perform transfer themselves in the best interests of the baby

PREPARATION AND PACKAGING

- Three components:
- clinical care (see above)
- location and checking of equipment
- allocation of team
- Transport equipment must be reserved for transport use only
- Team undertaking transfer must be trained in use of all equipment and drugs and be competent to perform any necessary procedures en-route
- Ensure air and oxygen cylinders are full before departure
- ETT and lines must be secured before transferring baby to transport incubator
- Baby must be secured in transport incubator

TRANSPORT

Before leaving referring unit

- Change to transport incubator gases (check cylinders are full)
- Check blood gas after changing to transport ventilator. Make any necessary changes
- Check lines and tubes are not tangled; check infusions are running
- Record vital signs
- Allow parents to see baby
- Contact receiving hospital to confirm cot still available and handover current clinical details (including infusions and ventilator settings)

Only leave referring unit when team leader is confident that baby is stable for transfer

On arrival at ambulance

- Ensure incubator and equipment are securely fastened/stowed in accordance with CEN standards
- Plug in gases and electrical connections
- Ensure temperature in ambulance is suitable
- Check all staff are aware of destination
- Discuss mode of progression to hospital (e.g. category of transfer)
- Ensure all staff/parents are wearing seatbelts before vehicle moves

During road transit

- Record vital signs
- If baby requires clinical intervention, stop ambulance in a safe place before staff leave their seats
- Make receiving team aware of any major changes in clinical condition

On arrival at receiving hospital

- Follow the ACCEPT structure
- Handover to receiving team and then transfer baby to the unit's equipment
- transfer and receiving teams to agree order in which transfer happens
- After transfer, dispose of any partially used drugs and infusions before returning to ambulance

TYPES OF TRANSFER (KIDS NTS SPECIFIC)

Uplift transfers

- Undertaken on day of referral once bed available

ITU/HDU

- Undertaken on day of referral once bed available

Special care transfers

- Referrer to confirm cot and handover to receiving unit
- Make referral to KIDS NTS between 0900–1800 hr on day before transfer
  - allows parents to be made aware of transfer, handover to be given and all documentation completed
- Referrer to confirm cot on day of transfer
  - KIDS NTS will call referring unit to plan time of transfer
  - referring unit **should not** call KIDS NTS on day of transfer

Drive through transfers for upper gastrointestinal study (commonly known as bilious vomiting pathway)

- Applies to mature babies (≥35 weeks) in the first 72 hr of life, who have not been discharged home and have no other co-morbidities, including confirmed infection
- Not suitable for babies on high flow oxygen or receiving mechanical ventilation
- Pathway available 0900–2200 hr
- Referrer to contact surgical tier 2 who will assess suitability and availability of 'back-up' bed
  - if suitable, referrer to contact KIDS NTS to make a referral and assess for suitability for transfer
  - if 'back-up' bed not available in accepting hospital, referring team may be asked to refer to alternative hospital

- Usually the result of:
  - maternal history of TB in pregnancy
  - baby exposed to a close (usually household) contact with sputum positive TB
- Effective management requires liaison between obstetric, neonatal, TB and paediatric ID teams

Risk factors for TB in newborn period

- Baby is at risk of acquiring TB if:
  - mother received treatment for <2 weeks **or** treated for >2 weeks but sputum smear positive
  - mother diagnosed with TB in postpartum period and/or after commencing breastfeeding
  - close household contact has sputum positive TB

Congenital TB

- Acquired from transplacental spread or at birth
- Rare but potentially devastating infection with high mortality
- Characterised by primary focus in liver, hepatosplenomegaly and a miliary or disseminated picture including respiratory dissemination and TB meningitis

Neonatal TB

- Much more common than congenital infection
- Baby infected through respiratory route from infected mother or other close contact
- Baby highly susceptible to severe respiratory and disseminated disease including TB meningitis and miliary TB

IMMEDIATE MANAGEMENT

- If maternal infection fully treated before pregnancy give BCG
- If mother has TB in pregnancy:
  - liaise with microbiology/TB specialist/paediatric ID consultant. Specialist may advise immediate anti-TB prophylaxis/treatment or investigations before treatment
  - if no features of TB disease, start prophylaxis with rifampicin (R) and isoniazid (H)
  - if RH resistance discuss with British Thoracic Society multi-drug resistant forum
- If mother had TB prophylaxis during pregnancy:
  - examine babies at birth
  - if no features of TB disease, give BCG

INVESTIGATIONS

- Gastric washings
  - taken early morning pre-feed and transported in alkali medium for microscopy for acid fast bacilli, urgent PCR for M tuberculosis and mycobacterial culture
  - liaise with microbiologist before sending
- Chest X-ray
- +/- CSF
- Maternal endometrial or placental samples may also be sent for TB testing

TREATMENT

- If baby has clinical signs, evidence of TB on chest X-ray or positive microbiology local specialist team will advise on treatment
- If baby well with normal investigations
  - Check renal and liver function
  - start isoniazid
    - add pyridoxine 5 mg daily
    - do not give BCG as this will be affected by isoniazid treatment
    - check liver function again after 2 weeks
- Mother with active-phase TB can breastfeed once smear negative after appropriate treatment

FOLLOW-UP

- Will be done by local specialist team
- Neonatal team to prescribe sufficient discharge medication to last until first specialist review as GP does not prescribe this

- Mantoux or IGRA (interferon gamma release assay) at the end of prophylaxis – if negative, give BCG. **Do not** give BCG if either Mantoux or IGRA have been positive at any stage

PARENT INFORMATION LEAFLET FOR TB IN PREGNANCY AND FOR PROPHYLAXIS IN BABY

- https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/851854/RA_Pregnancy_TB_Patients.pdf

UMBILICAL ARTERY CATHETER: INSERTION AND REMOVAL ● 1/4

Do not attempt to carry out this procedure unsupervised unless you have been trained to do so and have demonstrated your competence under appropriate supervision

INDICATIONS

- Frequent blood gas analysis:
  - ventilated babies (most babies treated with CPAP can be managed with capillary gases)
- Continuous monitoring of arterial blood pressure (if poor circulation or need for accurate BP)
- Exchange transfusion

CONTRAINDICATIONS

- Umbilical sepsis
- Necrotising enterocolitis (NEC)
- Evidence of vascular compromise in legs or buttocks
- Congenital abnormality of the umbilicus (e.g. exomphalos or gastroschisis)

EQUIPMENT

- Umbilical artery catheterisation pack
- Umbilical catheter: <2 kg use size 3.5 FG, ≥2 kg use size up to 5 FG
- 3-way tap
- Sterile gown, gloves and drape
- Infusion pump
- Sodium chloride 0.9% or 0.45% infusion containing heparin 1 unit/mL
- Umbilical tape
- Cleaning solution as per unit policy
- Zinc oxide tape or Elastoplast®

PROCEDURE

Consent

- Wherever possible inform parents of need and associated risks before procedure; if an emergency, delay explanation until after insertion
- Risks include sepsis and thrombosis
- See **Consent** guideline

Pre-sterile preparation

- Monitor baby's vital signs during procedure
- Estimate length of catheter to be inserted using formula: (weight in kg × 3) + 9 cm
  - alternative method for umbilical artery catheter (UAC) length is twice distance from umbilicus to mid-inguinal point, plus distance from umbilicus to xiphisternum
  - add length of cord stump to give final length
  - prefer high catheter position i.e. tip above diaphragm (T6–T10 vertebral bodies)
- Inspect lower limbs and buttocks for discolouration
- Tie an umbilical tape loosely around base of cord

Sterile preparation

- Scrub up, put on gown and gloves using aseptic technique
- Ask assistant (if available) to gently hold baby's legs and arms away from umbilical site
- Clean cord stump and surrounding skin with cleaning solution
- Attach 3-way tap to catheter and flush all parts with sodium chloride 0.9% leaving syringe attached
- Place all equipment to be used on a sterile towel covering a sterile trolley
- Place sterile drape with a hole in the centre over the umbilical stump. Pull the stump through the hole ready for catheter insertion
- Avoid using cleaning solution on skin surrounding umbilical stump in order to prevent chemical burns in extreme preterm babies (<26 weeks) – cleaning solution to be used on umbilical stump only

Insertion of arterial catheter

- Clamp across cord with artery forceps
- Apply gentle upward traction

UMBILICAL ARTERY CATHETER: INSERTION AND REMOVAL ● 2/4

- Cut along underside of forceps with a scalpel blade to reveal either the cut surface of the whole cord, or use a side-on approach and cut part way through the cord (on the artery) at a 45° angle
- Leave a 2–3 cm stump; remember to measure length of cord stump and add to calculated placement to give final advancement distance
- Identify vessels, single thin-walled vein and 2 small thick-walled arteries that can protrude from the cut surface (see **Figure 1**)
- Support cord with artery forceps placed near to chosen artery
- Dilate lumen using either dilator or fine forceps
- Insert catheter with 3-way tap closed to catheter. If resistance felt, apply gentle steady pressure for 30–60 sec
- Advance catheter to the calculated distance
- Open 3-way tap to check for easy withdrawal of blood and for pulsation of blood in the catheter

If catheter will not advance beyond 4–5 cm and blood cannot be withdrawn, it is likely that a false passage has been created.
Remove catheter and seek advice from a more experienced person

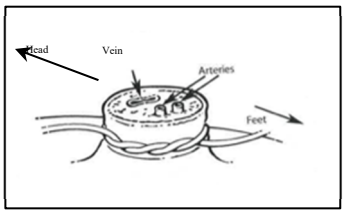


Figure 1: Identifying umbilical cord vessels

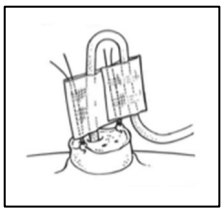


Figure 2: Effective system for more permanent fixation of umbilical catheters

Securing catheter

- If umbilical venous catheter (UVC) is also to be inserted, site both catheters before securing either. Secure each catheter separately to allow independent removal
- For each catheter place 2 sutures into cord, 1 on either side of catheter, allowing suture ends to be ≥5 cm long beyond cut surface of the cord. Sandwich catheter and ends of the 2 sutures between zinc oxide or Elastoplast®, tape as close to cord as possible without touching cord (like a flag) (see **Figure 2**). The sutures should be separate from the catheter on either side to allow easy adjustment of catheter length, should this be necessary. Top edge of sutures can be tied together above flag for extra security after confirming X-ray position
- alternatively, suture can be criss-crossed along shaft of catheter and secured
- If catheter requires adjustment, cut zinc oxide or Elastoplast® tape between catheter and the 2 suture ends, pull back catheter to desired length and retape; **never** advance once tape applied as this is not sterile
- Connect catheter to infusion of heparin 50 units in 50 mL sodium chloride 0.9% or 0.45% and run at rate of 0.5 mL/hr
- Confirm position of catheter by X-ray: unlike a UVC, a UAC will go down before it goes up
- a high position tip (above diaphragm but below T6) is preferred
- X-ray after line insertion should routinely be combined chest and abdominal
  - subsequent X-rays following line adjustment may be combined or dedicated chest/ abdominal, depending on initial and new estimated line positioning
- if catheter below the diaphragm, withdraw to L3–L4 (low position)
- if catheter position too high (above T6), withdraw to appropriate length
- if catheter length adjusted, repeat X-ray

UMBILICAL ARTERY CATHETER: INSERTION AND REMOVAL ● 3/4

Acceptable UAC tip positions

Tip position	Acceptable or unacceptable	Precautions/adjustments
T6–T10	Acceptable	Ideal high UAC position
L3–L4	Acceptable	Low UAC position
T11	Can be used with caution	Monitor blood sugar
L5	Can be used with caution	Monitor leg perfusion
T12–L2	Not acceptable	Risk of bowel or renal ischemia, pull back to L3–L4
Above T6	Not acceptable	Pull back to T6–T10
Femoral artery	Not acceptable	Risk of leg ischemia, replace with new UAC

Avoid L1, the origin of the renal arteries
Never attempt to advance a catheter after it has been secured;
either withdraw it to the low position or remove it and insert a new one

DOCUMENTATION

- Record details of procedure in baby's notes, including catheter position on X-ray and whether any adjustments were made
- Always label umbilical arterial and venous catheters using the appropriately coloured and labelled stickers
- Place traceability sticker from catheter/insertion pack into notes

AFTERCARE

- Nurse baby in a position where UAC can be observed
- Monitor circulation in lower limbs and buttocks while catheter is *in situ*
- Leave cord stump exposed to air
- Infuse heparin 50 units in 50 mL sodium chloride 0.9% or 0.45% at 0.5 mL/hr
- Do not infuse any other solution through UAC. Glucose or blood may be administered through UAC only in exceptional situations, on the authority of a consultant

COMPLICATIONS

- Bleeding following accidental disconnection
- Vasospasm: if blanching of the lower limb occurs and does not resolve, remove catheter (see **Vascular spasm and thrombosis** guideline)
- Embolisation from blood clot or air in the infusion system
- Thrombosis involving:
  - femoral artery, resulting in limb ischaemia
  - renal artery, resulting in haematuria, renal failure and hypertension
  - mesenteric artery, resulting in NEC (see **Vascular spasm and thrombosis** guideline)
- Infection: routine prophylactic antibiotics are not required, unless concerns of infection.

REMOVAL

Do not attempt to carry out this procedure unsupervised unless you have been trained to do so and have demonstrated your competence

INDICATIONS

- Catheter no longer required
- Catheter no longer patent
- Suspected infection
- Complications (e.g. NEC, vascular compromise to the lower limbs)

UMBILICAL ARTERY CATHETER: INSERTION AND REMOVAL ● 4/4

EQUIPMENT

- Sterile stitch cutter
- Sterile blade
- Umbilical tape
- Cleaning solution – as per unit protocol

PROCEDURE

- Wash hands and put on sterile gloves
- Clean cord stump with cleaning solution
- if umbilical tissue adherent to catheter, loosen by soaking cord stump with gauze swab soaked in sodium chloride 0.9%
- Ensure an umbilical tape is loosely secured around base of umbilicus
- Turn infusion pump off and clamp infusion line
- Take utmost care when cutting sutures not to cut through the arterial catheter
- Withdraw catheter slowly over 2–3 min, taking particular care with last 2–3 cm
- If bleeding noted, tighten umbilical tape
- Do not cover umbilicus with large absorbent pad, a small piece of cotton gauze should suffice
- Inspect catheter after removal: if any part missing, contact consultant immediately

AFTERCARE

- Nurse baby supine for 4 hr following removal, and observe for bleeding

COMPLICATIONS

- Bleeding
- Catheter tip inadvertently left in blood vessel

UMBILICAL VENOUS CATHETER: INSERTION AND REMOVAL ● 1/4

Do not attempt to carry out this procedure unsupervised unless you have been trained to do so and have demonstrated your competence under appropriate supervision

INDICATIONS

- All babies <1000 g
- Babies ≥1000 g ventilated or unwell (e.g. HIE) (a double lumen catheter may be indicated if baby requires significant support)
- Exchange transfusion
- Administration of hypertonic solutions (e.g. glucose >12.5%, parenteral nutrition or inotropes)

CONTRAINDICATIONS

- Umbilical sepsis
- Necrotising enterocolitis (NEC)
- Gastroschisis/exomphalos

EQUIPMENT

- Umbilical vein catheterisation pack
- suture (if not included in above pack)
- Umbilical venous catheter (UVC)
- 3-way tap
- Gown and gloves
- Sterile drape
- Infusion pump
- Sodium chloride 0.9% infusion or 0.45% if 0.9% is unsuitable
- Umbilical tape
- Cleaning solution as per unit policy
- Zinc oxide tape or Elastoplast®

PROCEDURE

- Wherever possible inform parents of need and associated risks before procedure; if an emergency, delay explanation until after insertion
- Risks include sepsis and thrombosis
- See **Consent** guideline

Pre-sterile preparation

- Monitor all vital signs during procedure
- Estimate length of catheter to be inserted: use distance between xiphisternum and umbilicus +1
- Remember to add length of cord stump to give final distance catheter needs to be advanced
- Tie umbilical tape loosely around base of cord

Sterile preparation

- Scrub up, and put on gown and gloves
- Use sterile technique
- Clean cord stump and surrounding skin with cleaning solution
- Avoid excessive solution to prevent chemical burns in extreme preterm babies
- Attach 3-way tap to catheter and flush all parts with sodium chloride 0.9%. Leave syringe attached
- Place all equipment to be used on sterile towel covering sterile trolley
- Drape umbilical stump with sterile towels
- Place sterile sheet with a hole in the centre over the cord. Pull the cord through the hole
- Avoid using cleaning solution on skin surrounding umbilical stump in order to prevent chemical burns in extreme preterm babies (<26 weeks) – cleaning solution to be used on umbilical stump only

Insertion of umbilical catheter

- Clamp across cord with artery forceps
- Apply gentle upward traction
- Cut along underside of forceps with scalpel blade cleanly to leave 2–3 cm stump or, if also placing an umbilical arterial catheter (UAC) and you have been trained in this procedure, consider using side-on technique (see **Umbilical artery catheter: insertion and removal** guideline)

UMBILICAL VENOUS CATHETER: INSERTION AND REMOVAL ● 2/4

Remember to measure length of cord stump and add to calculated placement distance to give final length catheter needs to be advanced

- Identify vessels (see **Figure 1**):
  - single thin-walled vein
  - 2 small thick-walled arteries that can protrude from cut surface
- Support cord with artery forceps placed near to vein
- Locate lumen of vein using either a dilator or fine forceps
- Insert catheter (3.5 F for babies with birth weight <1500 g and 5 F for those ≥1500 g) with 3-way tap closed to catheter
- Resistance often indicates malposition; withdraw catheter until it freely aspirates blood
- Advance catheter to desired distance, and open 3-way tap to check for easy withdrawal of blood

If catheter will not advance beyond 4–5 cm and blood cannot be withdrawn, it is likely that a false passage has been created. Remove catheter and seek advice from a more experienced senior person

Securing catheter

- If a UAC is also to be inserted, site both catheters before securing either. Secure each catheter separately as below to allow independent removal

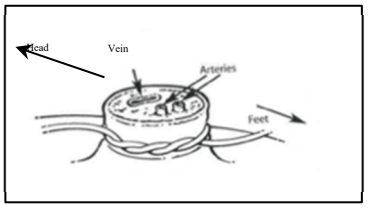


Figure 1: Identifying umbilical cord vessels

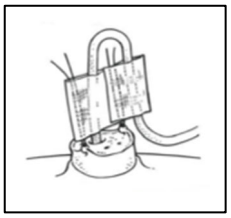


Figure 2: Effective system for more permanent fixation of umbilical catheters

- For each catheter place 2 sutures into cord, 1 on either side of the catheter, allowing suture ends to be ≥5 cm long beyond cut surface of cord. Bend the catheter in a loop, then sandwich it and ends of the 2 sutures between zinc oxide or Elastoplast® tape, as close to the cord as possible without touching cord (like a flag) (see **Figure 2**). The sutures should be separate from the catheter on either side as this allows easy adjustment of catheter length, should this be necessary. Top edge of sutures can be tied together above flag for extra security after confirming X-ray position
  - alternatively, suture can be criss-crossed along shaft of catheter and secured
- If catheter requires adjustment, cut zinc oxide or Elastoplast® tape between catheter and 2 suture ends, pull back catheter to desired length and retape; never advance once tape has been applied as it is not sterile
- Connect catheter to infusion of sodium chloride 0.9% or 0.45% if 0.9% is unsuitable
  - Confirm position of catheter in IVC by combined chest and abdominal X-ray (UVC that has passed into the IVC should travel vertically from the umbilicus)
  - optimal catheter placement: tip at T8–9 but not in heart or liver shadow (usually at the level of or just below diaphragm)
    - if tip at T10 or below:
    - check catheter still sampling
    - discuss with consultant
    - use short-term only (consultant decision to use at risk)
    - replace at earliest opportunity
- If catheter length adjusted, repeat X-ray
- X-ray after line insertion, routinely combined chest and abdominal
  - subsequent X-rays following line adjustment may be combined or dedicated chest/ abdominal, depending on initial and new estimated line positioning

DOCUMENTATION

- Record in notes details of procedure, including indication, description of catheter, number of attempts, length inserted, catheter position on X-ray and whether any adjustments were made
- Point of care ultrasound can be used to assess the tip of the line, but final confirmation of position must be done via X-ray

- Position to be verified in writing by consultant neonatologist/paediatrician/radiologist report
- Always label umbilical arterial and venous catheters, using the appropriately coloured and labelled stickers
- Place traceability sticker from catheter/insertion pack into notes

AFTERCARE

- Review need for catheter daily (if catheter tip at or below T10, replace with long line at earliest opportunity)
- Monitor circulation in lower limbs and buttocks whilst catheter *in situ*
- Leave cord stump exposed to air
- Catheter may remain in place for up to 7–10 days. If needed for >7 days consider insertion of long line due to increased risk of infection
- Any infusions must be connected to UVC using aseptic technique
- Catheters below T10 have increased risk of extravasation; can be used in the short-term but replace at earliest opportunity (consultant decision to use at risk)

COMPLICATIONS

- Air embolism
- Bleeding resulting from accidental disconnection
- Refractory hypoglycaemia due to malpositioning of catheter
- Infection: prophylactic antibiotics not required
- Thrombus formation
- Cardiac tamponade (see below)
- Any deterioration in a baby in whom a central venous catheter is present should raise the question of catheter related complications; particularly infection, extravasation, PN ascites and tamponade
- PN ascites may require urgent abdominal paracentesis

Cardiac tamponade

- Suspect in presence of:
- tachycardia
- poor perfusion
- soft heart sounds
- increasing cardiomegaly
- decreasing oxygen saturation
- arrhythmias
- Confirm diagnosis by:
- chest X-ray – widened mediastinum and enlarged cardiac shadow
- echocardiogram (if available)
- If there is cardiovascular compromise, consider drainage (see **Pericardiocentesis** guideline)

REMOVAL

Do not attempt to carry out this procedure unsupervised unless you have been trained to do so and have demonstrated your competence under appropriate supervision

INDICATIONS

- Central venous access no longer required
- Concerns regarding sepsis
- Remove after a maximum of 10 days

EQUIPMENT

- Sterile stitch cutter
- Sterile blade
- Cleaning solution as per unit policy
- Gown and gloves

PROCEDURE

- Wash hands and put on gown and gloves

- Clean cord stump with cleaning solution
- Turn infusion pump off and clamp infusion line
- Ensure umbilical tape secured loosely around base of umbilicus
- Take utmost care when cutting the sutures so as not to cut through the UVC
- Withdraw catheter slowly
- If any bleeding noted, tighten umbilical tape
- Confirm catheter intact
- If unit policy, send catheter tip to microbiology

AFTERCARE

- Nurse baby supine for 4 hr following removal and observe for bleeding

COMPLICATIONS

- Bleeding
- Catheter tip inadvertently left in blood vessel
- Infection

UPPER LIMB BIRTH INJURIES INCLUDING BRACHIAL PLEXUS PALSY ● 1/1

Not all neonatal brachial plexus palsies are due to birth injury – other reasons for uni- or bilateral palsies include transverse myelitis, osteomyelitis spine, spinal stroke, spinal abscess

TYPES OF BIRTH-RELATED UPPER LIMB INJURIES

- Brachial plexus palsy may be congenital occurring in-utero or acquired during delivery to injury from traction injury of brachial plexus nerves – may be unilateral or bilateral and can be associated with fractures of the ipsi- or contralateral clavicle or humerus
- Isolated fractures to humerus or clavicle
- Isolated radial nerve palsy of the newborn

ASSESSMENT OF ALL BABIES WITH REDUCED UPPER LIMB MOVEMENT

- Examine the arm and neck for swelling, bruising, tone, posture and degree of movement
- Assess for breathing difficulties and Horner's syndrome
- Document findings clearly in case notes
- Explain to parents that recovery probable but may not be complete
- Inform consultant obstetrician/paediatrician (in charge clinician)

MANAGEMENT

- X-ray humerus/clavicle to exclude fracture
- if fracture of clavicle clearly seen, reassure parents and review baby at 3 weeks when movement should be returning
- if fracture of humerus is clearly seen, offer strapping of arm to chest for comfort and contact paediatric orthopaedic surgeon for follow-up
- In case of classical waiter's tip position or other cases of peripheral nerve injury e.g., radial nerve palsy. UseTriVice app or web-based application for guidance if unclear pathway (see below)
- refer to Children's Hand and Upper Limb Service at BCH if no recovery of arm movement at 3 weeks. Refer by email to bwc.handsandupperlimb@nhs.net
- Refer to inpatient neonatal physiotherapist (where service is available) for an assessment before discharge
- If not seen by a physiotherapist before discharge, refer to local children's community physiotherapy service
- Paralysis of the arm, which is **completely** resolved does not need to be referred but if there is any doubt, **all** babies can be seen in a hand clinic, either remotely or face-to-face so that a specialist assessment can be made and the parents can be given appropriate information

BIRMINGHAM CHILDREN'S HAND AND UPPER LIMB SERVICE:

- Fax referrals will not be accepted
- For advice and guidance please use https://bwc.trivice.net or via the app TriVice (Triage, Referral and Advice) which can be downloaded for all NHS staff via App store and google store
- Any referral should be done by letter or email to bwc.handsandupperlimb@nhs.net
- Email secretary with referral: bwc.handsandupperlimb@nhs.net
- Tel: 0121 333 8136/8285

- **This guideline applies to babies managed jointly with Birmingham Children's Hospital. If this is not the referral pathway used locally, seek local advice**

ANTENATAL ASSESSMENT

Fetal diagnostic scans are undertaken at 18–20 weeks and may be repeated at 32–34 weeks

18–20 week scan

- anteroposterior diameter (APD)
- any calyceal dilatation
- ureteric dilation
- appearance of bladder

Possible urinary tract abnormalities

- Kidneys, collecting system and bladder (prognostic factors)

Kidneys

- Renal agenesis +/- oligohydramnios – Potter sequence
- Multi-cystic dysplastic kidney (MCDK), check other kidney for normal appearance
- Solitary kidney
- Abnormal position (e.g. pelvic) or shape (e.g. horseshoe)
- Kidneys with echo-bright parenchyma (suspect cystic diseases)

Collecting system

- Unilateral or bilateral renal pelvic dilatation (RPD)/pelviectasis
- Measured in antero-posterior diameter (APD)
- mild: RPD 5–9 mm
- moderate: RPD 10–14 mm
- severe: RPD ≥15 mm
- Unilateral or bilateral dilated calyces or ureter

Bladder

- Bladder (dilated or thick-walled; ureterocoele in bladder)

32–34 week scan

- To clarify urinary tract abnormalities found in early fetal scans
- Assess severity of RPD/pelviectasis:
- normal: RPD <7 mm
- mild: RPD 7–9 mm
- moderate: RPD 10–14 mm. If bilateral, suspect critical obstruction
- severe: RPD ≥15 mm. Suspect critical obstruction
- calyceal dilatation: often indicates severity; may suggest obstruction
- Parenchymal thinning: indicates severity and possible damage to kidney
- Unilateral/bilateral dilated ureter(s) – suspect obstruction or vesico-ureteric reflux (VUR)
- Thick-walled bladder, suspect outlet obstruction
- Dilated bladder, suspect poor emptying
- Ureterocoele, suspect duplex system on that side

Communication

- Provide mother with an information leaflet, if available in your hospital, about this antenatal anomaly and proposed plan of management after birth

POSTNATAL MANAGEMENT

- Ultrasound scan **must** comment on:
- APD at the hilum, transverse view in the prone position
- parenchymal thickness
- calyceal dilatation
- ureters
- bladder

Indications for intervention

Urgent

- Bilateral hydronephrosis RPD ≥10 mm +/- thick-walled bladder: suspect posterior urethral valves (boys) or other bladder outlet obstruction
- Unilateral hydronephrosis RPD ≥15 mm, without ureteric dilatation suspect pelvi-ureteric junction (PUJ) obstruction
- Significant abnormalities of kidney(s)/urinary tract – if risk of renal insufficiency
- check serum potassium, blood gas for metabolic acidosis and serum creatinine

Non-urgent

- All other abnormalities of urinary tract in the antenatal scan

IMMEDIATE MANAGEMENT

For urgent indications

- If posterior urethral valves (PUV) or bilateral hydronephrosis (PUJ obstruction suspected), check urine output/stream and monitor weight trend
- Arrange **urgent KUB ultrasound scan**, after 48 hr (see above parameters requiring reporting) as minimal milk intake may underestimate the size of renal pelvis, **but do not delay** if there is gross dilatation
- If postnatal scan raises suspicion of posterior urethral valves (dilated ureters + thick walled bladder)
- check serum creatinine
- arrange urgent micturating cysto-urethrogram (MCUG)
- after confirmation by MCUG, refer baby **urgently** to on-call paediatric urologist
- If unilateral RPD ≥20 mm with significant calyceal dilatation and thinned parenchyma (suggestive of PUJ obstruction) discuss with urologist and arrange MAG3 renogram as soon as possible/as advised by urologist (usually after 6–8 weeks)
- Significant abnormalities of kidney(s)/urinary tract – if risk of renal insufficiency:
- check serum potassium, blood gas for metabolic acidosis and serum creatinine
- start trimethoprim 2 mg/kg as single night-time dose
- Discuss with consultant before discharge

For non-urgent indications

- Renal ultrasound scan at aged 1 week and again at aged 6 weeks
- Consultant review with results

Antibiotic prophylaxis

- For RPD ≥12 mm, give trimethoprim 2 mg/kg as single night-time dose until criteria for stopping are met (see below)

SUBSEQUENT MANAGEMENT

- Subsequent management depends on findings of ultrasound scan at 6 weeks

Severe pelviectasis (RPD ≥15 mm with calyceal dilatation and thinned parenchyma)

- Arrange MAG3 scan – timing depends on severity of obstruction – as soon as possible if RPD ≥20 mm
- if MAG3 scan shows obstructed pattern, discuss with paediatric urologist
- Repeat ultrasound scan at aged 3 months
- If severe calyceal dilatation and/or parenchymal thinning, earlier ultrasound may be required
- Continue antibiotic prophylaxis until advised otherwise by urologist

Moderate unilateral pelviectasis (RPD 10–14 mm) and/or ureteric dilatation

- Presumed mild obstruction or VUR
- If RPD increases beyond 15 mm with calyceal dilatation and parenchymal thinning, arrange MAG3 scan at aged 6–8 weeks
- If VUR suspected, MCUG
- Continue prophylaxis for VUR >grade III (marked dilatation of ureter and calyces) until child is continent (out of nappies)
- Repeat scan 3-monthly in the 1st year, 6-monthly in the 2nd year and yearly until aged 5 yr, or until RPD <10 mm, then follow advice below
- Prophylactic antibiotics required **only** if there is ureteric dilatation

Normal or mild isolated pelviectasis (RPD <10 mm without calyceal dilatation or parenchymal thinning)

- Stop antibiotic prophylaxis
- Repeat scan after 6 months
- if 3 x 6 month scans show no change and there have been no urinary tract infections (UTIs), discharge
- If unwell, especially pyrexial without obvious cause, advise urine MC&S

MCDK

- DMSA to clarify nil function of MCDK and normal uptake pattern of other kidney
- Repeat ultrasound scan at 12 and 24 months to observe involution of kidney), then repeat at aged 10 yr (may take several years)
- Beware of 20% risk of VUR/PUJ obstruction in contralateral 'normal' kidney, advise parents to recognise UTI/pyelonephritis (especially if fever is without obvious focus)
- MCUG or prophylaxis until continent **ONLY** if dilated pelvis or ureter in good kidney
- Annual blood pressure check until kidney involuted
- If cysts persist >5 yr, enlarge or hypertension, refer to urology

Ureterocoele (75% occur with duplex kidney)

- MAG3 to check function and drainage from both moieties of the duplex system
- Prophylaxis until problem resolved
- Urology referral – sooner if obstruction suspected

Solitary kidney/unilateral renal agenesis

- Kidney ultrasound at 6 weeks to confirm antenatal findings and rule out other urogenital structural abnormalities
- DMSA to confirm absence of kidney and normal uptake pattern by the solitary kidney

Renal parenchymal problem requiring nephrology review

- Bright kidneys
- Multiple cysts

Other conditions

- Single umbilical artery in cord
- increased risk of renal abnormality but postnatal ultrasound scan only if antenatal scan missed or abnormal
- Ear abnormalities: ultrasound examination only if associated with:
- syndrome
- other malformations
- maternal/gestational diabetes
- family history of deafness

VARICELLA ● 1/3

RECOGNITION AND ASSESSMENT

Definition

- There are 2 separate presentations depending on timing of infection:
  - fetal varicella syndrome (FVS): maternal chickenpox infection before 20 weeks' gestation
  - neonatal varicella (NV): maternal infection in perinatal period or close contact with chickenpox or shingles in first 7 days after birth

FETAL VARICELLA SYNDROME (FVS)

Symptoms and signs

- Limb hypoplasia
- Scarring of skin in a dermatomal distribution
- Cortical atrophy, microcephaly, bowel and bladder sphincter dysfunction, vocal cord paralysis
- Chorioretinitis, cataracts and microphthalmia
- Intra-uterine growth restriction

Investigations

Maternal

- If no history of chickenpox, check maternal varicella zoster (VZ) IgG at time of contact
- If mother develops rash of suspected chickenpox but uncertain, to confirm send swab from base of vesicle in viral transport media for varicella zoster PCR
  - ideally send from community to avoid waiting rooms

Neonatal

- If clinical features of FVS and maternal history of chickenpox
  - for cranial US, ophthalmology examination
- If vesicles present send swab from base of vesicle in viral transport media for varicella zoster PCR, note FVS commonly has scarring which will not test positive by PCR

Management

- Management is supportive and requires long-term multidisciplinary follow-up
- Neither varicella zoster immunoglobulin (VZIG) nor aciclovir has any role in the management of these babies

NEONATAL VARICELLA – EXPOSURE

Baby born to mother who develops chickenpox rash (but not shingles) within 7 days before birth, or 7 days after birth

- Give VZIG 250 mg (1 vial approximately 1.7 mL) IV
  - antenatal chickenpox: give as soon as possible after delivery (must be within 72 hr)
  - postnatal chickenpox: give as soon as possible and within 10 days after initial exposure
  - consider giving in different sites in small babies
  - can be given without antibody testing of baby
- If VZIG not available or IM injection contraindicated, give 0.2 g/kg IVIG (less effective)
- Not indicated:
  - if neonatal chickenpox has developed
  - babies born after 7 days of appearance of maternal chickenpox
  - mother has zoster

Baby exposed to chickenpox or shingles (other than in the mother)

  - Significant exposure: household (same room), face-to-face for 5 min, in same room for >15 min with chickenpox or disseminated shingles, exposed shingles (e.g. ophthalmic), shingles in an immunocompromised person
- Case of chickenpox or disseminated shingles is infectious from 24–48 hr before onset of rash until crusting of lesions
- Localised shingles is infectious from day of onset of rash until crusting
- Non disseminated shingles can also be infectious if exposed directly to the lesions (e.g. on face/contact with effected dermatome)
  - particular risk in immunocompromised who have increased shedding. Any exposure to these is significant
- **Give VZIG** in the following cases of postnatal exposure to varicella:

- VZ IgG-negative babies (determined by testing mother for varicella antibodies) exposed to chickenpox or shingles from any other contact other than mother, in first 7 days of life (see **Decision pathway for VZV contact**)
- VZ IgG-negative babies of any age, exposed to chickenpox or herpes zoster while still requiring intensive or prolonged special care nursing
- babies exposed postnatally, regardless of maternal chickenpox history, who:
  - weighed <1 kg at birth, **or**
  - were ≤28 weeks' gestation at birth, **or**
  - are aged >60 days, **or**
  - have had repeated blood sampling with replacement by packed cell infusions. Perform VZ IgG assay and, if negative, give VZIG (at risk of not having received/retained sufficient maternal VZ IgG)

Decision pathway for non-maternal VZV contact
Other indications for prophylaxis of *a child > 4 weeks exposed to chicken pox*

- Remained in hospital since birth and:
- born <28 weeks **or**
- weigh <1000 g **or**
- severe underlying condition congenital or otherwise that require prolonged intensive or special care during the first year of life

Prophylaxis dose of acyclovir In child aged 4 weeks to 2 yr:

- 10 mg/kg 8-hrly IV from days 7 to 14 post exposure (if delay occurs can be started up until day 14 post exposure)

NEONATAL VARICELLA DISEASE

Signs of neonatal varicella

- Mild: vesicular rash
- Severe: pneumonitis, pulmonary necrosis, fulminant hepatitis
- mortality up to 30% (less if VZIG given)
- ensure not bacterial infection – this can coincide with VZV, cover both if suspected

Indications for IV treatment with aciclovir ANY of:

- Aged <1 month, **or**
- Born <28 weeks' gestation, **or**
- Birth weight <1000 g, **or**
- Signs of pneumonitis/other disseminated disease, **or**
- Unwell/ clinical concern at current condition or capacity to worsen

Aciclovir treatment of neonatal VZV

- 10–20 mg/kg IV (over 1 hr) 8-hrly, diluted to 5 mg/mL
- For renal impairment, refer to **Neonatal Formulary**
- Treat for ≥7 days; minimum 14 days if encephalitis present, up to 21 days if severe

SUBSEQUENT MANAGEMENT

Where

- On postnatal ward, unless baby requires neonatal intensive care support:
- isolate mother and baby together in separate room until 5 days after onset of rash and all lesions crusted over
- if baby already exposed, breastfeeding can continue, but explain to mother possible risk of transmission

Staff

- Exposed staff with no history of chickenpox, VZ vaccination or of unknown VZ IgG status to have VZ IgG measured by occupational health
- if VZ IgG negative, immunise with varicella vaccine
- remove from clinical duties during days 7–21 following exposure
- if in high-risk group for complications (immunocompromised), offer VZIG

MONITORING TREATMENT

- Aciclovir

- ensure good hydration
- stop once clinical improvement occurs, or when all lesions crusted

DISCHARGE AND FOLLOW-UP

Maternal infection

- After baby has had VZIG, discharge
- Advise mother to seek medical help if baby develops chickenpox, preferably via an open-access policy where available
- Advise GP and midwife to recommend admission to isolation cubicle if rash develops

Fetal infection

- Ophthalmic examination
- Cranial ultrasound
- Developmental follow-up

VASCULAR SPASM AND THROMBOSIS● 1/2

VASCULAR SPASM

Blanching or cyanosis of extremity following insertion or manipulation of peripheral or umbilical arterial catheter (UAC)

- **Remove catheter** unless absolutely essential
- **Elicit reflex vasodilation**
- reflex vasospasm on insertion of UAC can occasionally be corrected by reflex vasodilation by warming contralateral limb
- **Volume expansion**
- if appropriate, give sodium chloride 0.9% 10 mL/kg as volume expander
- **GTN patch**
- use can be considered to improve perfusion but not trialled or licensed for use in babies. Discuss with consultant
- Liaise with plastic surgeons, haematologists and other specialists as needed

VASCULAR THROMBOSIS

Clinical features suggesting vascular thrombosis

Site	Clinical signs	Diagnostic imaging
Peripheral or central (aorta or iliac) arterial thrombosis	• Pallor • Cold arm/foot • Weak or absent peripheral pulse • Discolouration • Gangrene • Difficulty establishing a proper pulse oximetry trace • Delayed capillary refill time on affected limb	• Doppler scan for large vessel thrombus (sensitivity and specificity uncertain in the neonatal period) • Real-time 2-dimensional ultrasound • CT scan with contrast • Contrast angiography (at specialised centre)
Renal artery/aortic thrombosis	• Systemic hypertension • Haematuria • Oliguria • Renal failure	
Renal vein thrombosis	• Flank mass • Haematuria • Hypertension • Thrombocytopenia	
Inferior vena cava thrombosis	• Cool lower limbs • Cyanosis • Oedema	
Superior vena cava thrombosis	• Swelling of upper limbs and head • Chylothorax	
Central venous line thrombus	• High pressures on long line • SVC obstruction • Chylothorax • Swelling • Discolouration of extremity	
Right atrial thrombus	• Heart failure • Embolic phenomenon	• Echo
Pulmonary thromboembolism	• Respiratory failure	• Lung perfusion scan (at specialised centre)

MANAGEMENT OF THROMBOEMBOLISM

- Controversial
- Inadequate controlled trials
- Inform consultant
- Liaise with plastic surgeons, haematologists and other specialists as required

VASCULAR SPASM AND THROMBOSIS● 2/2

Treatment options

Conservative

- Observe closely with no intervention e.g. unilateral renal vein thrombosis

Anticoagulation and thrombolysis

- No controlled neonatal trials
- Use only under guidance from haematologist and/or plastic surgeon

VENEPUNCTURE ● 1/2

- Venepuncture is the preferred method of blood sampling for term neonates and causes less pain than heel prick
- Comfort and pain management options during procedure include:
  - containment holding
  - maternal voice
  - swaddling
  - using sucrose

INDICATIONS

- Blood sampling in a baby without indwelling arterial line, or when sampling from arterial line or capillary sampling is inappropriate

EQUIPMENT

- Cleaning solution or cleaning swab – follow local infection control policy
- Request cards
- Non-sterile gloves
- 23 G blood sampling needle or needle-safe cannula
- **Do not use a broken needle**
- Sterile gauze/cotton wool to apply to wound post-procedure
- Sharps container

PROCEDURE

- Inform parents and gain consent

Preparation

- Wash hands and wear gloves (see **Infection prevention** guideline)
- Position of baby (immobilisation is crucial to baby's safety whilst undergoing phlebotomy, and to success of procedure)
  - skin-to-skin or safely parent held
    - if not possible, swaddle with single limb exposed
  - if baby to be bled on a surface, comfort hold
- Pain relief – expressed breast milk (EBM)
  - if EBM not available, offer sucrose
- Identify suitable vein (typically back of hand or foot)
- Place paper towels under limb to avoid blood dripping onto bed linen

Insertion and sampling

- Apply hand pressure around limb to distend vein
- Clean the puncture site then do not touch again
- Place thumb on skin slightly distal to proposed puncture site
- Hold needle at 10–20° angle and puncture skin
- Advance needle toward vein. Resistance may diminish slightly as needle enters vein and blood will be seen to flow
- Collect required volume taking care to mix but not shake blood
- When sampling complete, release the pressure from around the limb, place gauze over insertion point, but do not apply pressure until needle is out
- Maintain pressure on site until bleeding ceases

Complications

- Inability to obtain specimen due to:
  - inappropriate choice of vein
  - thrombosed vein (due to previous/repeated attempts)
  - inexperienced operator
  - A baby in shock, cold or dehydrated causing vasoconstriction.

Unsuccessful attempts

- Adhere strictly to a limit on number of attempts
- If no satisfactory sample collected after 2 attempts, seek second opinion as to whether to make a further attempt or cancel procedure

- Defer to a more experienced operator
- Venous distension:
  - use warm pack to encourage vasodilation and venous filling
- Transillumination of limb can help identify suitable vein

Avoid:

- Veins close to an infection, bruising and phlebitis
- Thrombosed veins
- Oedematous limbs – danger of stasis of lymph, predisposing to complications e.g. phlebitis and cellulitis
- Areas of previous venepuncture – build-up of scar tissue can cause difficulty accessing vein and result in pain
- Sampling from potential IV infusion site or long line vein (e.g. cubital fossa or long saphenous) whenever possible

Haemolysis risk factors

- Use of larger than 3 G needle, or too large a gauge for vessel
- Drawing blood specimens from IV or central line
- Under-filling tube – ratio of anticoagulant to blood >1:9
- Reusing tubes that have been refilled by hand with inappropriate amounts of anticoagulants
- Mixing tube too vigorously
- Failing to let alcohol/disinfectant dry
- Using too great a vacuum, e.g. using too large a tube or syringe
- Squeezing can cause haemolysis and elevate serum potassium

Completion and organisation

- Keep track of all needles used and dispose of them in sharps container
  - do not re-sheath needle
- Dispose of rubbish and clean tray
- Remove gloves and wash hands
- Label all samples and investigation forms at cot side (and crosscheck with second checker)
- Arrange for transfer of samples to laboratory
- Document in patient notes

SAFETY OF PRACTITIONER

- Wear well-fitting gloves during procedure to prevent contamination from potential blood spills
  - gloves will not prevent needle stick injury, however the wiping effect of glove on needle may reduce volume of blood to which hand exposed
- Discard used needles directly into sharps container – **do not** re-sheath
- Report any incident/accident linked to needle or sharp injury **immediately**, and follow local needlestick injury policy

VENTILATION: CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) ● 1/4

See **Ventilation: high-flow nasal cannulae (HFNC)** guideline

DEFINITION

- Non-invasive respiratory support utilising continuous distending pressure during inspiration and expiration in spontaneously breathing babies

Benefits

- Improves oxygenation
- Reduces work of breathing
- Maintains lung volume
- Lowers upper airway resistance
- Conserves surfactant

INDICATIONS

- Early onset respiratory distress in preterm babies
- Respiratory support following extubation
- Respiratory support in preterm babies with evolving chronic lung disease
- Recurrent apnoea (in preterm babies)
- Atelectasis
- Tracheomalacia

CPAP following extubation

- Consider in babies <32 weeks' gestation

CONTRAINDICATIONS

- Any baby fulfilling the criteria for ventilation
- Irregular respirations
- Pneumothorax without chest drain
- Nasal trauma/deformity that might be exacerbated by use of nasal prongs
- Larger, more mature babies often do not tolerate application of CPAP devices well
- Congenital anomalies:
- diaphragmatic hernia
- choanal atresia
- tracheo-oesophageal fistula
- gastroschisis

TYPES OF CPAP **(exact CPAP device will vary from unit to unit)**

1. **Standard CPAP**
2. **Two-level CPAP**

1. STANDARD CPAP

Equipment

- Short binasal prongs and/or nasal mask
- Circuit
- Humidification
- CPAP generating device with gas mixing and pressure monitoring
- All require high gas flow (usual starting rate 8 L/min)

Fixing nasal CPAP device: short binasal prongs (preferred)

- To avoid loss of pressure, use largest prongs that fit nostrils comfortably
- Ensure device is straight and not pressed hard against nasal septum or lateral walls of nostrils. Excessive pressure can cause tissue damage

Nasal mask

- Fit securely over nose

- consider alternating mask with prongs, particularly if baby developing excoriation or erosion of nasal septum. Masks can also result in trauma, usually at the junction between the nasal septum and philtrum
- Masks can give a poor seal and can obstruct

Procedure

Position baby

- Prone position is preferable
- Avoid excessive flexion, extension or rotation of the head

Set up equipment (see specific manufacturer instructions)

- Connect humidification to CPAP
- Connect CPAP circuit with prongs to CPAP device
- Place CPAP hat on baby
- Turn on CPAP flow and set pressure
- Attach CPAP circuit to CPAP hat and apply prongs/mask

Pressure range

- Start at 5–6 cm H_2O initially and increase by 1 cm H_2O increments
- Optimum pressure depends on illness type and severity – watch baby and use lowest pressure required to improve work of breathing

High pressures (≥10 cm H_2O) may restrict pulmonary blood flow, increase air leak risk and cause over-distension

CPAP 'failure'

- 'Failure of CPAP' implies a need for ventilation. Consider intubation and surfactant for preterm babies on CPAP as initial therapy if early chest X-ray demonstrates RDS and if any of the following apply:
- FiO_2 >0.3 with CPAP pressure 6 cm H_2O
- marked respiratory distress
- persistent respiratory acidosis
- recurrent significant apnoea
- irregular breathing

Checks

- Before accepting apparent CPAP 'failure' exclude:
- pneumothorax
- insufficient pressure
- insufficient circuit flow
- inappropriate prong size or placement
- airway obstruction from secretions
- open mouth

Complications

- Erosion of nasal septum: reduce risk by careful prong placement and regular reassessment
- Gastric distension: benign, reduce by maintaining open nasogastric tube

Weaning CPAP

When

- Start when baby consistently requiring FiO_2 <0.3, pressure 5 cm H_2O and stable clinical condition
- If nasal tissue damage significant, consider earlier weaning

How: 'Pressure reduction' or 'Time off'

- **Pressure reduction**
- more physiological approach although can increase the work of breathing if pressure is too low. Has been shown to be quicker than ‘time off’ mode
- wean pressures in steps of 1 cm H_2O every 12–24 hr. If no deterioration discontinue CPAP after 24 hr of 4–5 cm H_2O and minimal oxygen requirement
- **Time off CPAP**
- plan using 2 × 12 or 3 × 8 hr time periods

- The following regimen of cycling CPAP can be adapted to individual situations

Day 1	1 hr off twice a day (1 off, 11 on)
Day 2	2 hr off twice a day (2 off, 10 on)
Day 3	3 hr off twice a day (3 off, 9 on)
Day 4	4 hr off twice a day (4 off, 8 on)
Day 5	6 hr off twice a day (6 off, 6 on)
Day 6	Off CPAP

Note: High-flow humidified oxygen therapy
- Increasingly used as non-invasive respiratory support
- Offers theoretical advantages over CPAP in ventilating upper airway spaces and producing less nasal tissue damage
- When weaning CPAP, consider using 5–6 L/min of high-flow humidified oxygen (e.g. Vapotherm® or Optiflow™) rather than low-flow nasal cannulae oxygen or lower pressure CPAP

Failure of weaning
- Increased oxygen requirement, increasing frequency of apnoeas associated with bradycardias and cyanosis, increasing respiratory distress and/or worsening respiratory acidosis during weaning should necessitate a review and consider escalation of support

2. BiPAP (TWO-LEVEL CPAP)

- Two-level CPAP at a rate set by clinician (biphasic) or triggered by baby using an abdominal sensor (biphasic trigger or Infant Flow® SiPAP)
- Inspiratory time, pressures and apnoea alarm limit set by clinician
- Indications/contraindications as CPAP and can be used when baby's clinical condition is not improving despite CPAP

Theoretical advantages over CPAP
- Improved thoraco-abdominal synchrony
- Better chest wall stabilisation
- Reduced upper airway resistance
- Reduced work of breathing

Specific modes of two-level CPAP (specific names vary with manufacturer)

CPAP and apnoea
- CPAP with added advantage of apnoea monitoring via sensor attached to abdomen
- Apnoea alarm triggered when no breaths detected within set time-out period

Biphasic
- Bi-level pressure respiratory support with/without apnoea monitoring
- Higher level pressure above baseline CPAP delivered intermittently at pressure, rate and inspiratory time set by clinician
- Not synchronised with respiratory effort

Biphasic trigger (tr)
- Bi-level pressure respiratory support with inbuilt apnoea monitoring
- Higher level pressure above baseline CPAP at rate determined by, and in synchrony with, baby's respiratory effort sensed through abdominal sensor
- Pressure, inspiratory time and back-up rate set by clinician

Clinical use

Biphasic
- Begin with CPAP pressure of 5–6 cm H_2O
- Set peak inspiratory pressure (PIP) at 3–4 cm H_2O above CPAP and rate 30 breaths/min
- Keep T_{insp} and apnoea alarm delay at default setting
- If CO_2 retention occurs, review baby and consider increase in rate and/or PIP
- Avoid over-distension and keep PIP to minimum for optimum chest expansion

VENTILATION: CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) ● 4/4

Weaning
- By rate and pressure
- If rate >30 breaths/min, wean to 30 breaths/min
- Reduce MAP, by reducing PIP by 1 cm H_2O every 12–24 hr
- When baby breathing above 30 breaths/min change to biphasic tr mode
- When MAP 5–6 cm H_2O, change to CPAP

Biphasic tr
- Begin with CPAP pressure of 5–6 cm H_2O with PIP at 3–4 cm H_2O above CPAP
- Keep T_{insp} and apnoea alarm delay at default setting
- Set back-up rate at 30 bpm

Weaning
- Reduce MAP by reducing PIP by 1 cm H_2O every 12–24 hr
- Once MAP 5–6 cm H_2O, change to standard CPAP
- If deterioration occurs during weaning process, assess baby and consider returning to biphasic mode

VENTILATION: CONVENTIONAL ● 1/4

NICE NG124 recommends that preterm babies having invasive ventilation are given volume-targeted ventilation in combination with synchronised ventilation
***Refer to separate guideline* Ventilation: Volume-targeted**
This guidance is for babies where volume targeted modes cannot be used at the time

INTRODUCTION

Oxygenation

- Increase oxygenation by increasing:
- FiO_2
- peak end expiratory pressure (PEEP)
- peak inspiratory pressure (PIP)
- inspiratory time (T_{insp})

CO_2

- Reduced by:
- increased PIP
- increased rate
- occasionally by reducing excessive PEEP (beware of effect on oxygenation)

VENTILATOR PARAMETERS

PIP

- Use lowest possible PIP to achieve visible chest expansion and adequate gas exchange on blood gas analysis
- to minimise lung injury from barotrauma and inadvertent over-distension, avoid excessive PIP
- need for higher pressures [e.g. mean airway pressure (MAP) >12 cm] could lead to consideration of high frequency oscillatory ventilation (HFOV) [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]

PEEP

- Use a PEEP ≥4 cm and increase incrementally up to 8 cm for improving oxygenation but when PEEP >6 cm necessary, take senior advice

T_{insp}

- Usually between 0.3–0.4 sec
- Avoid T_{insp} >0.5 sec except in term babies with parenchymal lung disease where a T_{insp} up to 1 sec may be used

Rate

- Fast-rate (≥60/min) ventilation is associated with fewer air leaks and less asynchrony compared to slow (20–40/min) rates
- If rate >70/min required, HFOV may be a more appropriate option [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]

Flow

- Flow 5–8 L/min is generally sufficient
- Consider higher flows at faster ventilatory rates or shorter inspiratory times
- SLE ventilator has a fixed flow (5 L/min) that cannot be altered

Tidal volume (V_t)

- **Target is 4–6 mL/kg**
- **Confirm that baby is receiving intended tidal volume before and after adjusting ventilation**

SETTING UP VENTILATOR

- Switch on humidifier and follow manufacturer's recommended settings for optimum temperature and humidity

Setting 1

- When an admission of a preterm baby requiring ventilatory support (for recurrent apnoea, see **Setting 2**)
- rate 60/min

- PIP 16–18 cm H_2O
- PEEP 5 cm H_2O
- T_{insp} 0.3–0.4 sec
- FiO_2 as required
- flow 6–8 L/min (not applicable to SLE)
- Adjust ventilatory settings depending on chest movement, SpO_2, and measured V_t
- Sample blood gas within 30 min of commencing ventilatory support

Setting 2

- For babies with **normal** lungs requiring supportive ventilation such as term babies with respiratory depression (asphyxia or drugs), babies with neuromuscular disorders or, in the post-operative period, and preterm babies with recurrent apnoea, set ventilator at following settings:
- rate 40/min
- PIP/PEEP 14–16/4 cm H_2O
- T_{insp} 0.35–0.4 sec
- FiO_2 as required (often 0.21–0.3)

ADJUSTING VENTILATORY SETTINGS

Adjusting FiO_2

- Oxygen is a drug and should be prescribed as with other medications. This should be done by specifying intended target range of SpO_2 on baby's drug chart
- Suggested target SpO_2 ranges (see **Oxygen saturation targets** guideline)
- preterm babies: 91–95%
- term babies: generally 96–100% but adjust according to the pathology (see **Pulmonary hypertension** and **Congenital heart disease: duct-dependent lesions** guidelines)

Target pCO_2

- Day 1–3: 4.5–8.5 kPa
- Day 4 onwards: 4.5–10 kPa provided pH remains >7.22 if allowing for permissive hypercapnia in preterm babies
- Try to avoid pCO_2 <4.7 kPa when ventilated
- If low PCO_2 wean ventilation without delay and recheck within 1 hr of low measurement

Altering ventilatory settings according to blood gases

If blood gases are outside the targets, first check the following:

- **Reliability of blood gas:**
- is the blood gas result reliable?
- has there been a sudden unexpected change from previous blood gas values?
- did sample contain an air bubble?
- was it obtained from a poorly perfused site?
- **Baby's status:**
- is baby's chest moving adequately?
- how is the air entry?
- **Ventilator and tubing**
- is there an air leak? [transilluminate to exclude (see **Transillumination of the chest** guideline)]
- what is the V_t?
- are the measured ventilatory values markedly different to the set ones?
- is there a large (>40%) endotracheal tube (ETT) leak?

Remember to exclude airway problems (blocked/displaced ETT) and air leaks in case of deterioration of blood gases. If available, use Pedicap® or end-tidal CO_2 monitoring to exclude ETT malposition

- Small frequent changes are more appropriate than large infrequent ones

Blood gas scenario	Recommended action *in order of preference*
Low PaO_2/SpO_2	• Exclude air leak/displaced ETT/over-inflation • Increase FiO_2 • Increase PEEP

	• Increase PIP (but be aware of effect on $PaCO_2$) • Increase T_{insp} [but ensure adequate expiratory time (T_{exp}), especially at fast rates] • Consider further surfactant [see **Surfactant replacement therapy – including less invasive surfactant administration (LISA) technique** guideline] • If above measures unsuccessful, discuss with consultant (may need HFOV/iNO)
High PaO_2	• Decrease FiO_2 (unless already in air) • Decrease PEEP (if >5 cm) • Decrease PIP (especially if $PaCO_2$ is also low)
High $PaCO_2$	• Exclude air leak/displaced or blocked ETT • Increase PIP • Increase rate (if chest not moving well). Do not use rates above 60/min • Decrease PEEP (only if oxygenation adequate and PEEP >6 cm) after taking senior advice
Low $PaCO_2$	• Decrease PIP • Decrease rate
Low PaO_2/SpO_2 and high $PaCO_2$	• Exclude displaced/blocked ETT • Exclude air leak • Increase PIP • Consider further surfactant • If no response, consider HFOV [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]

All ventilator changes must be prescribed and signed for on the intensive care chart

Load all babies ≤30 weeks' gestation with caffeine as early as possible after birth and ideally before aged 3 days. Give maintenance doses thereafter. Do not delay loading until the weaning stage

WEANING

- While weaning baby off ventilator:
- reduce PIP (usually by 1–2 cm) until MAP 7–8 cm reached
- thereafter, reduce rate to 20/min, usually in decrements of 5–10 breaths/min

Extubation

- Extubate babies <30 weeks' gestation onto nasal CPAP or HFNC – for mode, see **Ventilation: Continuous positive airway pressure (CPAP)** or **Ventilation: High-flow nasal cannulae (HFNC)** guideline
- more mature babies with no significant chest recessions can be extubated directly into incubator oxygen

BABIES FIGHTING VENTILATOR

If baby in asynchrony with the ventilator (fighting)

- Ensure baby is not hypoxic or under-ventilated
- Exclude blocked ETT
- Look for obvious pain e.g. necrotising enterocolitis
- If possible, change to synchronised form of ventilation (VTV/HFOV/SIMV)
- If sedation required, ensure it is adequate. Muscle relaxation seldom necessary and used only if IV morphine infusion (usually 10–20 microgram/kg/hr) already commenced

CARE OF VENTILATED BABY

Ventilated babies to have:

- Continuous electronic monitoring of heart rate, ECG, respiratory rate, SpO_2 and temperature
- Transcutaneous monitoring can be useful in preterm infants on invasive ventilation who are clinically unstable. Discuss with consultant

- Blood pressure
- consider continuous measurement of arterial blood pressure in babies ≤28 weeks' gestation, and those >28 weeks needing FiO_2 >0.6
- cuff measurement 4-hrly in acute phase where arterial blood pressure not being measured
- 6-hrly blood gas (arterial or capillary) measurement during acute phase of disease
- Hourly measurement of colour, and measured ventilatory parameters. If sudden drop in V_t, check air entry
- Daily monitoring of intake, output and weight
- Do not routinely use morphine for babies on respiratory support
- if commenced regularly assess baby to ensure it is stopped as soon as possible

PARENT INFORMATION

Offer parents the following information, available from:
https://www.bliss.org.uk/parents/in-hospital/about-neonatal-care/equipment-on-the-unit-1

VENTILATION: HIGH-FLOW NASAL CANNULAE (HFNC) ● 1/1

DEFINITION
Delivery of humidified, heated and blended oxygen/air at flow rates between 1–8 L/min via nasal cannulae

INDICATIONS
- Treating or preventing apnoea of prematurity
- Respiratory support for babies with:
  - respiratory distress syndrome – first line or post-extubation
  - chronic lung disease
  - meconium aspiration
  - pulmonary oedema
  - pulmonary hypoplasia
  - pneumonia
- Babies slow to wean off nasal CPAP
- Babies with nasal trauma from nasal CPAP

SETTING AND FLOW RATE
- Set operating temperature at 36–38°C
- Start at flow rate of 4–6 L/min (flow rates <6 L/min in babies <2 kg)
- Use ≤8 L/min in babies ≥2 kg
- **Ensure that air can exit freely around the prongs**

MONITORING
Continuously
- Heart rate (including ECG)
- Respiratory rate
- SpO_2
- Note: Monitor blood gases if on supplemental oxygen or on clinically indicated

WEANING FLOW RATES
(This weaning mainly applies to babies born <34 weeks' gestation, as some babies born ≥34 weeks may come off high flow without need for weaning)

FiO_2 >0.3	May not be possible to wean flow rate
FiO_2 <0.25 in baby ≥1.0 kg	Attempt to reduce by 1.0 L/min 24-hrly
FiO_2 <0.25 in baby <1.0 kg	Attempt to reduce by 1.0 L/min 48-hrly
FiO_2 0.25–0.3	Attempt to reduce by 1.0 L/min 48-hrly
Requiring <4.0 L/min	• If baby in air, attempt to stop (baby in air does not require nasal prong oxygen) • If baby in oxygen, put in 0.2 L/min of nasal prong oxygen initially
• Clinical instability • Increased work of breathing • Significant increase in FiO_2	Escalate treatment Consider pneumothorax (rare)

CONTRAINDICATIONS
- Upper airway abnormalities
- Ventilatory failure
- Severe cardiovascular instability
- Frequent apnoeas (despite caffeine in preterms)

VENTILATION: HIGH FREQUENCY OSCILLATORY VENTILATION (HFOV) ● 1/3

Decision to initiate HFOV must be made by a consultant. Do not start HFOV unless you have been trained to do so and have demonstrated your competence

INDICATIONS

- Rescue following failure of conventional ventilation (e.g. PPHN, MAS)
- To reduce barotrauma when conventional ventilator settings are high
- Airleak (pneumothorax, PIE)

Less effective in non-homogenous lung disease

TERMINOLOGY

Frequency	High frequency ventilation rate (Hz, cycles/sec)
MAP	Mean airway pressure (cm H_2O)
Amplitude	Delta P or power is the variation around the MAP

MECHANISM

Oxygenation and CO_2 elimination are independent

Oxygenation is dependent on MAP and FiO_2	MAP provides constant distending pressure equivalent to CPAP, inflating the lung to constant and optimal lung volume, maximising area for gas exchange and preventing alveolar collapse in the expiratory phase
Ventilation (CO_2 removal) dependent on amplitude	The wobble superimposed around the MAP achieves alveolar ventilation and CO_2 removal

MANAGEMENT

Preparation for HFOV

- If significant leakage (>20–30%) around ETT, insert a larger one
- Optimise blood pressure and perfusion, complete any necessary volume replacement and start inotropes, if necessary, before starting HFOV
- HFOV can worsen hypotension by increasing intrathoracic pressure and reducing venous return
- Invasive blood pressure monitoring if possible
- Ensure adequate sedation
- Muscle relaxants not necessary unless already in use

Initial settings on HFOV

MAP

Optimal (high) lung volume strategy (aim to maximise recruitment of alveoli)	• If changing from conventional ventilation, set MAP 2–4 cm H_2O above MAP on conventional ventilation • If starting immediately on HFOV, start with MAP 8 cm H_2O and increase in 1–2 cm H_2O increments until optimal SpO_2 achieved • Set frequency to 10 Hz
Low volume strategy (aim to minimise lung trauma)	• Set MAP equal to MAP on conventional ventilation • Set frequency to 10 Hz

- Optimal (high) volume strategy preferred but consider low volume strategy when air leaks present

Amplitude (delta P on SLE ventilator)

- Gradually increase amplitude until chest seen to wobble well
- Obtain early blood gas (within 20 min) and adjust settings as appropriate
- **Change frequency only after discussion with consultant**

VENTILATION: HIGH FREQUENCY OSCILLATORY VENTILATION (HFOV) ● 2/3

Making adjustments once HFOV established

	Poor oxygenation	Over-oxygenation	Under-ventilation	Over-ventilation
Either	Adjust MAP (+/- 1–2 cm H_2O)*	Decrease MAP (1–2 cm H_2O) when FiO_2 <0.4	Increase amplitude	Decrease amplitude
Or	Increase FiO_2	Decrease FiO_2		

* both over and under-inflation can result in hypoxia. If in doubt, perform chest X-ray

MONITORING

- Amplitude maximal when chest 'wobbling', minimal when movement imperceptible
- Frequent blood gas monitoring (every 30–60 min) in early stages of treatment as PaO_2 and $PaCO_2$ can change rapidly
- If available, transcutaneous $TcPCO_2$
- CO_2 diffusion coefficient (DCO_2)
  - indicator of CO_2 elimination which correlates well with $PaCO_2$ for an individual baby
  - calculated as frequency × (tidal volume)^2

Chest X-ray

- Within 1 hr to determine baseline lung volume on HFOV (aim for 8 ribs at midclavicular line)
  - if condition changes acutely and/or daily to assess expansion/ETT position, repeat chest X-ray

TROUBLESHOOTING ON HFOV

Chest wall movement

- Suction indicated for diminished chest wall movement indicating airway or ETT obstruction
- Always use an in-line suction device to maintain PEEP
  - increase FiO_2 following suctioning procedure
  - MAP can be temporarily increased by 2–3 cm H_2O until oxygenation improves
    - NOTE: high MAP can reduce chest wobble and cause hypotension

Falling DCO_2

- Suggests rising $PaCO_2$

Low PaO_2

- Suboptimal lung recruitment
  - increase MAP
  - consider chest X-ray
- Over-inflated lung
  - reduce MAP: does oxygenation improve? Check blood pressure
  - consider chest X-ray
- ETT patency
  - check head position and exclude kinks in tube
  - check for chest movement and breath sounds
  - check there is no water in ETT/T-piece
- Air leak/pneumothorax
  - transillumination (see **Transillumination of the chest** guideline)
  - urgent chest X-ray

High $PaCO_2$

- ETT patency and air leaks (as above)
- Increase amplitude, does chest wall movement increase?
- Increased airway resistance (MAS or BPD) or non-homogenous lung disease, is HFOV appropriate?
  - may be due to over expansion – discuss chest X-ray with consultant

Persisting acidosis/hypotension

- Over-distension
  - reduce MAP: does oxygenation improve?
- Exclude air leaks; consider chest X-ray

Spontaneous breathing

- Usually not a problem but can indicate suboptimal ventilation (e.g. kinking of ETT, build-up of secretions) or metabolic acidosis

WEANING

- Reduce FiO_2 to <0.4 before weaning MAP (except when over-inflation evident)
- When chest X-ray shows evidence of over-inflation (>9 ribs), reduce MAP
- Reduce MAP in 1–2 cm decrements to 8–9 cm 1–2 hrly or as tolerated
- If oxygenation lost during weaning, increase MAP by 3–4 cm and begin weaning again more gradually. When MAP is very low, amplitude may need increasing
- In air leak syndromes (using low volume strategy), reducing MAP takes priority over weaning the FiO_2
- Wean the amplitude in small increments (5–15%) depending upon PCO_2

Do not wean the frequency

- When MAP <8 cm H_2O, amplitude 20–25 and blood gases satisfactory, consider switching to conventional ventilation or extubation to CPAP

VENTILATION: SYNCHRONOUS POSITIVE PRESSURE VENTILATION (SIPPV) ● 1/3

NICE QS193 recommends that preterm babies having invasive ventilation are given volume targeted ventilation in combination with synchronised ventilation

DEFINITION

A form of synchronous ventilation in which baby triggers/initiates the breath while ventilator does the work of breathing. In other words, rate of ventilation is determined by baby while pressures are determined by operator via ventilator

SETTING UP TRIGGER VENTILATION

- Set humidifier temperature at 39°C (negative 2) to achieve airway temperature of 37°C

Set up Babylog® (Drager)

- Flow 6–10 L/min
- Select SIPPV mode
- Select highest trigger sensitivity (1: bar is all unshaded)
- Select T_{insp} (inspiratory time) between 0.3–0.4 sec
- Adjust T_{exp} (expiratory time) to achieve back-up rate of 35–40/min
- Peak inspiratory pressure (PIP) 16–18 cm H_2O
- Peak end expiratory pressure (PEEP) 5 cm H_2O
- FiO_2 to achieve target SpO_2 for gestation (see **Oxygen saturation targets** guideline)

Set up SLE 5000/6000

- Select patient triggered ventilation (PTV) mode
- Select highest trigger sensitivity (0.2 L/min for ≤28 weeks' gestation, 0.4–0.6 L/min for >28 weeks' gestation). Look at baby to confirm triggering adequately by observing baby generated breaths are triggering ventilator support
- Select T_{insp} for back-up breaths between 0.3–0.4 sec
- Set back-up rate of 35–40/min
- PIP 16–18 cm H_2O
- PEEP 5 cm H_2O
- FiO_2 to achieve target SpO_2 for gestation (see **Oxygen saturation targets** guideline)
- Software allows compensation for a leak of 10–60%
- Observe tidal volume (Vt) settings to confirm between 4–6 mL/kg

Baby

- If gestation <34 weeks, consider loading baby with IV caffeine citrate (20 mg/kg)
- Discontinue sedation

INITIATING TRIGGER VENTILATION

- Once baby connected to ventilator:
- check SpO_2 (see **Oxygen saturation targets** guideline) and adjust FiO_2 accordingly
- check baby's chest moving adequately, and measured Vt. Chest expansion should be just visible, and Vt should be between 4–6 mL/kg. If not, adjust PIP/PEEP to maintain adequate oxygenation and ventilation
- check ventilator triggering in synchrony with baby. Assess by **listening** to ventilator while **watching** baby's respiratory effort

Most likely cause of baby 'fighting' ventilator is ASYNCHRONY (see* Management of asynchrony*)

SUBSEQUENT ADJUSTMENTS ON SIPPV

- Check blood gas within 30 min of initiation of SIPPV
- Aim for:
- PaO_2: 6–10 kPa or target appropriate SpO_2 level (see **Oxygen saturation** guideline)
- $PaCO_2$: 4.5–8.5 kPa day 1–3, 4.5–10 kPa day 4 onwards
- pH >7.25

To improve oxygenation

- Increase FiO_2
- Rule out pneumothorax

- Increase PIP and/or PEEP
- Increase T_{insp} (not more than 0.4 sec)

To decrease $PaCO_2$
- Rule out pneumothorax
- Increase PIP
- Check if baby triggering adequately. If not, try shortening T_{insp}, or increasing back-up rate

Low $PaCO_2$
- Decrease PIP
- Decrease back-up rate if >35/min (if baby not breathing above this rate)
- In a vigorous hypocapnic baby, transfer to synchronised intermittent mandatory ventilation (SIMV) at a rate of at least 20/min

GENERAL SUPPORT
- Monitor SpO_2 continuously
- Check arterial blood gases at least 4–6 hrly depending on stage of disease
- In babies successfully ventilated in SIPPV mode, sedation is unnecessary
- Remember, most common cause of baby fighting ventilator is ASYNCHRONY. Always carry out checks and adjustments (see **Management of asynchrony**)
- If baby still 'fights' ventilator, consider morphine bolus (50–100 microgram/kg)
- If baby continues to 'fight' ventilator, use continuous sedation and change to other conventional ventilation (SIMV) mode (see **Ventilation: conventional** guideline)

Do not use muscle relaxants unless, despite carrying out above checks, baby cannot be ventilated. If muscle relaxants necessary, revert to conventional ventilation (see* Ventilation: conventional *guideline)

NURSING OBSERVATIONS
While baby on SIPPV, hourly observations
- Back-up rate set
- Baby's own respiratory rate
- Vt (in mL)
- Minute ventilation [MV (in 1/min)]

If alarm goes off, check
- Synchrony between baby and ventilator
- Excessive water droplets in ventilator tubing
- Flow graph for evidence of blocked tube or excessive T_{insp}
- Disconnection

MANAGEMENT OF ASYNCHRONY
Checklist
- Is endotracheal tube (ETT) patent (look at flow graph and Vt)
- Is T_{insp} too long? (is baby exhaling against ventilator?), if so shorten T_{insp} to 0.3 sec
- Is back-up rate too high? If so, consider dropping to 30–35 breaths/min
- Is there water condensation in ventilator tubing?
- If all above fails, consider morphine bolus (100 microgram/kg) over 3–5 min
- If baby still continues to 'fight' ventilator, use continuous sedation and revert to SIMV

AUTOCYCLING (FALSE TRIGGERING)
- False triggering occurs when ventilator delivers a mechanical breath artefactually when baby not actually initiating a spontaneous respiration
- Usually results from presence of water droplets in ventilatory circuit, or an excessive ETT leak
- If baby's trigger rate appears to be in excess of 80/min, ensure this is actual rate by observing baby's own respiratory movements. If not:
- check ventilatory circuit for excessive water condensation and empty if necessary
- decrease trigger sensitivity by increasing trigger threshold e.g. from 0.4 to 0.6 L/min

- Look for amount of ETT leak on Babylog display. If in excess of 50%, consider changing to slightly wider ETT

WEANING FROM SIPPV

- Once baby stable (triggering above set rate, saturating in FiO_2 <0.3), wean by:
- decreasing PIP by 1–2 cm H_2O each time (in SIPPV/PTV mode, weaning rate in a baby who is already triggering above it is useless)
- check baby breathing regularly and effortlessly (no chest recessions), and blood gases and oximetry are acceptable
- once PIP between 14–16 cm H_2O (depending on size of baby), consider extubation
- assess need for nasal CPAP/high-flow by checking for chest recessions, spontaneous minute ventilation, and regularity of breathing
- During weaning $PaCO_2$ can rise above 7 kPa and Vt may fall below 4 mL/kg
- provided baby triggering well, is not visibly tired, and pH >7.25, no action required
- if poor triggering, visibly tired or abnormal pH, increase PIP, and later back-up rate

VENTILATION: VOLUME-TARGETED (VOLUME GUARANTEE/TARGETED TIDAL VOLUME) ● 1/2

NICE QS193 recommends that preterm babies having invasive ventilation are given volume targeted ventilation in combination with synchronised ventilation

DEFINITION

In volume-targeted ventilation (VTV) gas delivery is targeted to deliver a pre-set tidal volume. Inspiratory pressure varies with each breath, depending on resistance and underlying lung compliance. The ventilator measures expired tidal volume (Vte) and calculates the pressure required to deliver this volume for the next breath. Available as volume guarantee (VG) on Draeger Babylog®, targeted tidal volume (TTV) on SLE 5000 and VTV on SLE 600

Benefits

- Compared with pressure-controlled ventilation, VTV can reduce:
  - mortality
  - bronchopulmonary dysplasia
  - pneumothorax
  - hypocarbia
  - severe intraventricular haemorrhage and periventricular leukomalacia

INDICATION

- Primarily used in preterm babies with surfactant-deficient lung disease requiring ventilation
- May be useful in other situations requiring ventilation

CONTRAINDICATION

- ETT leak >50%
- Caution to be used in situations such as pneumothorax, tracheo-oesophageal /bronchopleural fistula; leak may be increased and affect ventilation

TIDAL VOLUMES TO USE

- Vte used as less influenced by ETT leaks
- Vt 4–6 mL/kg
- 5 mL/kg reasonable starting volume
- Acute respiratory distress syndrome (RDS) 4–6 mL/kg
  - baby <750 g: 5–6 mL/kg (minimum starting volume 3 mL if 6 mL/kg is <3 mL)
  - baby 750–999 g: 4.5–5 mL/kg
  - baby ≥1000 g: 4–4.5 mL/kg
- Chronic lung disease: 5–8 mL/kg
- Avoid Vte >8 mL/kg (associated with volutrauma)
- Avoid Vte <3.5 mL/kg (associated with atelectotrauma)
- Change Vte in 0.5 mL/kg increments

MODE

- VG/TTV combined with SIMV, SIPPV, assist control (PTV) or pressure-support ventilation (PSV)
  - VG also available for PC-CMV and HFO modes on Draeger VN-500 ventilator
- In SIMV mode, set rate of ≥40/min (baby breaths are unsupported)
- PSV has additional advantage of synchronising inspiration termination.

PEAK PRESSURES

- Start PIP limit (Pmax) of ~25–30 cm H_2O
- Once baby stable and gases satisfactory adjust Pmax to 5–6 cm H_2O above average PIP needed to deliver set tidal volume
  - usually set ≤30 cm H_2O in preterm babies
- If PIP progressively increases or is persistently high, or if set Vt not delivered, reassess baby
- PEEP set at 4–6 cm H_2O

VENTILATOR RATE

- In baby with poor respiratory drive, use rates of 50–60 bpm
- Lower rates of 30–40 bpm can be used with good respiratory drive

VENTILATION: VOLUME-TARGETED (VOLUME GUARANTEE/TARGETED TIDAL VOLUME) ● 2/2

- Use T_{insp} (inspiratory time) of 0.3–0.4 sec; in PSV mode, set maximum T_{insp} at 0.5–0.6 sec – actual T_{insp} is adjusted by the ventilator
- Set flow trigger sensitivity at 0.2–0.4 L/min

WEANING

- Pressure weans automatically as lung compliance improves
- Avoid tidal volumes <3.5 mL/kg as increases work of breathing in small babies
- In SIMV, rate reduced to 40 breaths/min. VG/TTV is unhelpful with SIMV rates <40/min as baby breaths are unsupported. Attempt extubation when:
  - FiO_2 <0.3
  - MAP falls consistently <8 cm H_2O
  - baby has good respiratory drive and satisfactory gases

TROUBLESHOOTING AND PREVENTING PROBLEMS

High CO_2 (blood gases)

- Review baby
- Is set Vte being delivered?
- Is chest expansion adequate?
- Has leak increased? Change baby's position before increasing Pmax
- If ETT displaced/obstructed, or pneumothorax suspected, perform chest X-ray

Low CO_2 (blood gases)

- Decrease Vte by 0.5 mL/kg but maintain ≥4 mL/kg (≥2.5 mL total volume)
- Change to SIMV
- Lower trigger sensitivity
- Check for water in circuit (auto-triggering)
- Decrease rate by 5–10 bpm (in SIMV mode only)
- Increase PEEP (maximum 8 cm H_2O)

Low SpO_2

- Review baby
- Exclude air leaks
- Worsening RDS: may require additional surfactant dose
- Evidence of PPHN (see **Pulmonary hypertension** guideline)
- Increase FiO_2
- If Vte not delivered, increase Pmax
- Baby may benefit from change to high frequency [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]
- Exclude congenital heart disease

Low Vte alarm

- ETT leak >50%
- Pneumothorax
- Poor compliance/high resistance: increase Pmax

Baby persistently tachypnoeic

- Increase Vte by 0.5–1.0 mL/kg even if gases normal
- Review sedation

VENTILATOR ASSOCIATED PNEUMONIA (PREVENTION) ● 1/1

HAND HYGIENE

- Meticulous hand hygiene before and after patient contact and handling respiratory equipment or condensate
- wear gloves and apron when handling ventilator condensate and other respiratory/oral secretions

INTUBATION

- Use a new, sterile ETT for each intubation attempt
- use sedation +/- video laryngoscopy for planned procedure to reduce need for multiple attempts
- Ensure ETT does not contact environmental surfaces before insertion
- Use a sterilised or clean single use laryngoscope
- Have ≥2 NICU staff members present for ETT retaping/repositioning

SUCTIONING PRACTICES

- Clear secretions from the oropharynx before:
- ETT manipulation
- patient repositioning
- extubation
- re-intubation

ETT SUCTION

- Only when indicated
- Do not use sodium chloride instillation routinely
- For open suction, use 'suction function' on ventilator (if available) to prevent spray of condensate

FEEDING

- Adjust enteral feeding (See **Nutrition and enteral feeding** guideline). Abdominal distension and vomiting increase risk of reflux and aspiration

POSITIONING

- Keep head of bed elevated 15–30°
- Ensure no condensate in ventilator tubing before turning

ORAL CARE

- Use colostrum/breast milk, or sterile water if no breast milk available (See **Nutrition and enteral feeding** guideline)
- Carry out oral care:
- ≤24 hr after intubation
- every 3–4 hr
- before re-intubation as time allows
- before orogastric tube insertion

RESPIRATORY EQUIPMENT

- Use a separate suction catheter for oral and tracheal suction
- Drain ventilator condensate away from baby every 2–4 hr and before repositioning
- Avoid disconnection of ventilator circuit – only disconnect if:
- emergency use of Neopuff™ or ETT re-intubation
- change of circuit
- unable to remove condensate by manipulation of tubing
- Do not routinely disconnect ventilator circuit when turning baby
- Change ventilator circuit when visibly soiled or mechanically malfunctioning in addition to manufacturer's instructions
- Clean Neopuff™ connector with alcohol wipe after each manual contact with the ETT adapter
- Use heated ventilator circuits

VITAMIN K ● 1/3

INDICATIONS

Prophylaxis

- Babies are relatively deficient in vitamin K (phytomenadione). Those who do not receive supplements are at risk of bleeding [vitamin K deficiency bleeding (VKDB), formerly known as haemorrhagic disease of the newborn)]
- All babies should be given vitamin K with parental consent

Therapy

- After blood has been taken for clotting studies, vitamin K can also be used to treat any baby with active bleeding that might have resulted from vitamin K deficiency
- a prolonged prothrombin time (INR ≥3.5) that falls within 1 hr of treatment, with normal platelet count and fibrinogen concentration suggest the diagnosis. However, as INR is a poor indicator of vitamin K deficiency, PIVKA-II is a better investigation if available

ADMINISTRATION

Prophylaxis

- Vitamin K (Konakion MM Paediatric™) as a single IM dose (see **Prophylaxis dosage** below for dosage schedule)
- avoid IV administration for prophylaxis as it does not provide the same sustained protection as IM
- Give in accordance with manufacturer's instructions in order to ensure clinical effectiveness
- If parents decline IM route, offer oral vitamin K as second line option (no evidence of increased childhood cancers with parenteral vitamin K)
- give 2 doses vitamin K 2 mg oral in the first week
  - first: at birth
  - second: aged 4–7 days
- third dose vitamin K 2 mg oral given aged 1 month, unless baby exclusively formula fed (formula feeds contain adequate vitamin K)
- If parents decline vitamin K in hospital/community, healthcare professional to clearly inform parents of risks of VKDB (risk of significant bleeding in the brain and that there have been cases where babies have died from this bleeding);vitamin K will prevent this risk
- document conversation in patient records
- provide leaflet (if available) explaining risks and benefits of vitamin K
  - give parents opportunity to read leaflet, and hold second conversation to ascertain if they now wish to consent

IM use

- Do not dilute or mix with other parenteral injections

Oral use

- Break open ampoule and withdraw 0.2 mL (2 mg) into the oral dispenser provided. Drop contents directly into baby's mouth by pressing plunger

Table 1: Prophylaxis dosage

	Konakion MM Paediatric™
Healthy babies of ≥36 weeks and ≥2500 g	**First line** • 1 mg IM at birth or soon after **Second line** • 2 mg oral at birth, then • 2 mg oral at 4–7 days, then • 2 mg oral at 1 month unless exclusively formula fed
Term babies at special risk • Instrumental delivery, caesarean section • Maternal treatment with enzyme-inducing anticonvulsants (carbamazepine, phenobarbital, phenytoin), rifampicin or warfarin • Requiring admission to NNU • Babies with cholestatic disease where oral absorption likely to be impaired	1 mg IM at birth or soon after (Oral vitamin K if IM route declined but not preferable)
Preterm babies <36 weeks but ≥2500 g	1 mg IM at birth or soon after
All babies <2500 g	400 microgram/kg (0.04 mL/kg) IM shortly after birth (maximum dose 1 mg) Do not exceed this parenteral dose The frequency of further doses should depend on coagulation status
Babies who have or may have Factor VIII or Factor IX deficiency or other coagulation deficiency	Unless results of Factor assays normal, give orally – consult with local haematologist

For babies with birth weight ≥2500 g

- Administer Konakion MM Paediatric™ 1 mg (0.1 mL) IM
- this is approximately **half** of the ampoule volume and should be drawn up using syringe supplied with ampoule

For babies with birth weight <2500 g

- Administer 400 microgram/kg (0.04 mL) with a maximum of 1 mg (0.1 mL) of Konakion MM Paediatric™ IM
- round up the dose to nearest hundredth [e.g. 300 microgram (0.03 mL), 500 microgram (0.05 mL) etc.]
- draw up the dose using syringe supplied with ampoule

Table 2

Weight (kg)	Dose (mg)	Injection volume (mL)
1	0.4	0.04
1.5	0.6	0.06
2	0.8	0.08
2.5	1	0.1
>2.5	1	0.1

Therapy dosage

- If not already given IM, give vitamin K 100 microgram/kg IV up to 1 mg maximum dose
- Further doses as required, depending on clinical picture and coagulation status
- may need to be accompanied by a more immediately effective treatment such as transfusion of fresh frozen plasma

IV administration

- If necessary, dilute
- dilution in glucose not recommended for IV administration due to reactions with syringes, but drug can be added to lower port of syringe giving set administering glucose 5% at rate ≥0.7 mL/min (= 42 mL/hr)